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THE BOOK OF BRITISH FERNS.

Yours truly

Chas T Druery

THE BOOK

OF

BRITISH FERNS.

BY

CHAS. T. DRUERY, F.L.S., V.M.H.,

PRESIDENT OF THE BRITISH PTERIDOLOGICAL SOCIETY.

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PREFACE.

THE great variability which characterises nearly all the British species of Ferns, coupled with the long-continued assiduity of Fern hunters and raisers, has led to such an immense accumulation of varieties that a complete list is rendered an impossibility. From time to time lists have been compiled in as exhaustive a fashion as possible, some being simple catalogues of names, as Mr. P. Neill Fraser's, and others, as, for instance, Mr. E. J. Lowe's "British Ferns" (Swan Sonnenschein and Co., 1891), giving descriptions, names of raiser or finder, and date of origin in addition, while in "Ferns of the Lake District," edited first by Mr. J. M. Barnes, and subsequently by Mr. G. Whitwell, a purely local list is given on similar lines. In 1888, the editor also published "Choice British Ferns" (Upcott Gill), which embraced a selection of the best forms then extant. In all these lists, however, the nearer they approach numerical completeness the greater the number of forms they embrace, which, in these later days, must be considered inferior. As a wild find every distinct and marked form, if constant, is of interest, but now that we have arrived at a time when such finds run into hundreds, and it is seen that not only are many of them of very similar types, or what is more to the point, are more curious than beautiful, the need has arisen for a list on purely selective lines, embracing only the pick, and rejecting all such faulty ones as may not possess some sufficiently redeeming character in another direction. Such a list, therefore, the British Pteridological Society, at their meeting in August, 1899, determined to furnish, and the following gentlemen were elected as a committee to that end: Dr. F. W. Stansfield, C. T. Druery, J. Edwards, W. Forster, W. H. Phillips, J. J. Smithies, W. Troughton, G. Whitwell, and J. A. Wilson, the writer undertaking the compilation and editorship. Great pains have been taken by all concerned to confine the list as far as possible to really fine symmetrical and constant forms. Exceptions as regards constancy had necessarily to be made in such cases as A. f. f. Kalothrix, Polyp. v. elegantissimum, S. v. Drummondiæ, and others in which the dimorphic features appear rather to enhance than detract from their interesting character; otherwise exclusion has been on strict lines.

In compiling this list the thanks of the Society are due to all those whose catalogues have been used as a basis of selection, and especially to the late Mr. E. J. Lowe, whose little book above cited loses none of its value as a full record of all types by the side of this avowedly selected one. The Society's list appeals to those who desire to form a collection of the finest kinds, Mr. Lowe's, to those who, having found or raised a presumably new thing, need such a book for reference as regards classification or confirmation of absolute novelty.

To render the list of greater general value it has been supplemented by a description of the various species and chapters on culture, propagation, &c., which constitute it a handy one for reference by beginners as well as connoisseurs, to which end it is also framed on non-technical lines, and the popular nomenclature adhered to. Where varieties have received more than one name from different authorities, the better or best descriptive one has been chosen, and in most cases, where personal names only have been applied, a properly descriptive one has been allotted, *e.g.*, A. f. f. Edwardsii, see congestum minus.

The chapter on Fern crossing and hybridising appeared originally in the "Journal of the Royal Horticultural Society," and by the courtesy of the Editor it is reproduced with the illustrations. For the benefit of those who may desire to pursue the study of Ferns beyond the popular limits, an appendix has been added, treating of the reproductive phenomena, normal and abnormal, with reprints of papers given before the Linnæan Society, and republished by permission of the Council.

Finally, the Editor's best thanks are due to those members of the Committee who have assisted him, and particularly to Mr. W. H Phillips for his data relating to Colonel A. M. Jones' Nature Prints, to Dr. F. W. Stansfield, who has revised the eventual compilation, and thus by his great experience rendered it at once trustworthy and valuable as a descriptive index of the best forms extant at the end of the nineteenth century, and to those who have kindly furnished illustrative photographs.

CHAS. T. DRUERY, F.L.S., V.M H.
(*President of the British Pteridological Society.*)

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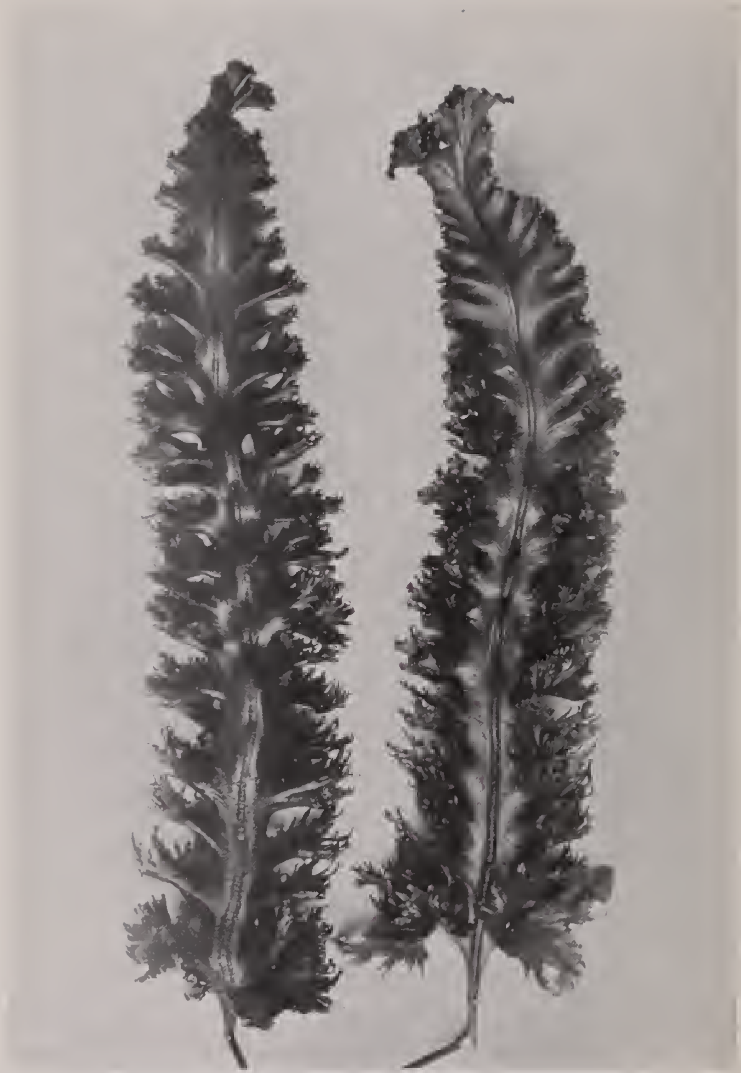


Scolopendrium vulgare var. fimbriatum cristatum.

THE BOOK OF BRITISH FERNS.

SELECTIONS AND DESCRIPTIONS.

IT is really astonishing how few people even amongst plant lovers are aware that in our British Ferns and their varieties we have something absolutely unique in the world and unparalleled anywhere outside our little group of islands, despite the fact that elsewhere in many places Ferns are far more abundant and species far and away more numerous. No collection can be made of any other class of plants without some aid from outside; either the plants themselves are originally exotic or the varieties are due to culture abroad as well as here, but with our British Ferns not only have we many hundreds of lovely and diverse forms, every one of which is of home origin, either as a wild find or derived therefrom in this country, but in no other part of the world has a tithe of such diversity been found to exist, even in those places which are infinitely better endowed with raw material than we are. Whether this singular fact is due to a greater capacity for sporting in our native species, owing to climatic or other conditions, or whether it is due to the fact that here alone we have had a persistent coterie of Fern hunters engaged for half a century in this peculiar cult, we cannot with certainty say, but, from some little experience abroad, we incline to the latter belief. Anyway, the facts remain that we have such a wealth of beautiful native Ferns at our disposal, and that, on the principle perhaps that a prophet has no honour in his own country, we practically ignore the gift it constitutes at the hand of beneficent Nature. The most peculiar feature perhaps is that a love for Ferns is so general that thousands upon thousands of gardens display these self-same species in their shady corners, but almost invariably in their common forms, while the far more beautiful varieties are, as we have said, ignored. In cool or cold conservatories we also find specimens to which the same remark applies, yet we venture to think that a glance at our picture, page 19, which represents by the unflattering aid of photography a conservatory devoted entirely to the Ferns we are championing (with the single exception of a chance exotic in the background, Woodwardia radicans), should suffice to convince anyone that they are worthy to rank amongst the very *élite* of decorative foliage plants. Then, too, they are essentially fitted to be the pets of all classes, their perfectly hardy nature precludes the necessity of any heating in the winter, they do not rank as expensive plants to procure, and, finally, with a little attention to their needs they are practically everlasting. Their diversity of size as well as form fits them, too, for all grades of accommodation. Given ample space, examples of the grandest may be grown, eclipsing the finest exotics in delicacy of cutting or eccentricity of design, while on the other hand, if space be limited, 100 dwarfs can be accommodated within a few square yards. In the Midlands, where the British varieties are mainly appreciated, in many a window we may see lovely specimens of frilled or tasselled Hart's-tongues and crested forms of other species to which none of the elsewhere popular window plants can possibly be advantageously compared. We ourselves, in the early days of our enthusiasm, devoted a north basement window to a small collection, which evidently constituted a source of wonderment to the passers-by, and eventually quite converted a local nurseryman to the cult. Since that time, by the efforts of the late Colonel A. M. Jones, E. J. Lowe, and Mr. Carbonell, Kew has been enriched with a grand representative collection of varieties more than a decade since, and yet we may walk all London through, and for the matter of that, all Britain through as well, and, save in the Midlands, hardly find a sign of their existence. We yield to no one in admiration of the lovely exotic Ferns which have been introduced, but we submit that it is a ridiculous state of things that a charming thing found abroad is eagerly snatched up by the trade, while an equally fine thing found in our native Fern haunts is absolutely ignored, except by the coterie of enthusiasts. Half a century ago, in the fifties, the merit of our British Ferns found popular acknowledgment, and for a time there was a "craze;" unfortunately, however, the trade, as is evidenced clearly by contemporary catalogues, put a great lot of rubbish on the market, *i.e.*, irregular and unsymmetrical curiosities, their very defects enhancing their prices in many cases. The result inevitably was a revulsion of taste, from which, from that day to this, the Ferns have suffered. Since then, however, the types have been more and more refined. The abundance of good things found led to stricter and stricter selection, until at last we are able to put forward a list compiled on proper lines, in full confidence that no one who starts a collection using it as his or her guide will eventually regret the trouble taken or will feel anything but gratitude to us for our recommendation.

Our native British Ferns have immensely advanced and improved. At the outset of the past century Ferns generally were an enigma to the biologist, and their varietal capacity only known to a minute extent, contemporary books alluding vaguely to a few monstrosities which might certainly be reckoned on the fingers. In the middle of the century "varieties" became the study of the pioneers, and some scores of fine forms had been found and many more good and bad had been raised. Since then a comparative handful of Fern lovers have sustained the cult and practically reformed it; the result is this list, and another result, we hope, will be a fuller appreciation in the present century of the outcome of their labours.

CULTURE AND PROPAGATION.

IN the culture of Ferns, as with all other plants, the nearer we can approach the conditions under which they grow wild and luxuriantly the greater will be our success and the fewer our disappointments. In the introductory matter relative to each species we have indicated their special habitats, likes, and dislikes, and therefore here we need only briefly refer to general principles. Ferns are survivors from a period when the earth was doubtless warmer, cloudier, and damper than now; our coal formations have been bequeathed to us by Ferns and their kin, and undoubtedly we are indebted to the same source for all our present wealth of trees and flowering plants. Hence, although many species in tropical and sub-tropical climes have adapted themselves to hot and even dry positions, the great majority still affect situations away from hot sunshine and risk of continuous drought, and naturally, in a comparatively moist climate like Britain, the species native thereto have been evolved to fit it. Consequently it is in woods, shady lanes, and secluded glens that we find our Ferns at their best. Thus, the first thing is to avoid an excess of sunshine. The next thing is to avoid wind, not merely on account of the drying nature of some winds, but far more because the friction set up between the fronds is bound to seriously damage them, especially when we are dealing with some of our finest cut varieties. Thirdly, drought must be avoided at the roots, and the more humid the air the finer the development. On the other hand, the more light we can give the better, since light is with Ferns, as with all vegetation, absolutely necessary; and as regards drought, drainage, as we have repeatedly stated elsewhere, must be attended to, as a stagnant soil means disease and death to the Ferns implanted therein. These are the fundamental principles of success, and now to other considerations.

First and foremost, we strongly advocate single crown culture as far as possible, that is, keeping a Fern to one centre of growth, and not permitting it to form a crowd by means of its offsets. The shuttlecock section of Ferns, or those which send up their fronds in a circle round a central core, are very apt to develop young plants from the bases of the fronds outside the circle, and these if left alone speedily assume adult size, and in so doing jostle their parents, mix up their fronds together, battle for existence underground with their roots, and, as a result, all the individuals to a certain extent are dwarfed, while the consequent crowding of the fronds detracts from their beauty and grace. A single crown kept so by persistent removal of such youngsters will have fronds double the size, and with their varietal characters doubly enhanced, so that a magnificent symmetrical circle of heavily-tasselled 4 feet fronds replaces an unsightly 2 feet clump of greatly inferior character. With many Ferns this eliminating process eventually results in a non-production of further offsets, but in others the central crown itself splits gradually into two, and in this case it is necessary to wait until they get quite independent, when they can be divided with the aid of a knife and gentle pressure. Ferns with creeping roots, such as the Polypodies, are obviously not open to such treatment, but the simple fact that they travel prevents that struggle for existence at the roots, and all that is needful is to plant them in pans instead of pots, and so facilitate their rambles and help their development.

PROPAGATION.

Obviously a simple means of propagation exists in these offsets we have alluded to. Each one, if carefully detached, will be found to have its own little bunch of roots, and all that is needed is to plant them in good compost and leave them alone to establish themselves, and so with the larger established crowns. Many varieties, especially of the Shield Ferns (Polystichum), bear bulbils or little plants on the fronds, and these only require layering to take root. The best plan is to sever the frond and peg it down entire

Asplenium Trichomanes at Home.

until the youngsters make a start; they can then be lifted and cut apart for separate potting or planting. Ferns with creeping root-stocks are easily propagated by simply cutting into pieces, each piece consisting of a growing tip, a frond, and its respective bunch of roots. Finally, pieces of old crowns carefully cleansed from all dead portions and inserted in soil under glass will often develop young plants from latent bulbils. The old bases of Hart's-tongue fronds do this freely, each piece producing a clump of youngsters.

SPORES.

Undoubtedly, however, the propagation of Ferns through their spores is the most interesting way of all. Apart from the immense number which can so be obtained, certainly at some sacrifice of time, there is always the chance when dealing with varietal spores of getting something new and so contributing to the advance of the cult. The chief thing here is to start well by only sowing good things. For the beginner the Lady Fern, Male Fern, and Hart's-tongue are perhaps the easiest to raise, though the Bracken (P. aquilina), if a good tasselled or other variety be sown, is the quickest to reward the sower with typical plants. Starting, then, with any one of these, we shall find in the early autumn, at the back of the fronds, patches or lines of brownish powder, containing the spores. Cut off a piece of a frond so furnished and lay it on glazed paper in a warm room, and in a few hours we shall find the paper apparently stained brown in similarly shaped patches. This brown stain is really the spores themselves, which have been shed from the capsules, and if we scrape a tiny pinch off and put it under a microscope we shall find an incalculable number present, possibly a million or so, and therefore quite enough for a beginner to start with. We have now the material; the next thing is to deal with it so as to transform it into Ferns. Experts do this in various ways, but our practice is as follows: We take a small 2½-inch pot or shallow pan, with a hole for drainage, and nearly fill this with ordinary Fern compost, first putting in some crocks covered with a little moss to admit of drainage, and on the top of this compost we sprinkle some little lumps of loam. We now take a kettle of boiling water, and, placing a piece of paper on the soil to prevent washing up, saturate it repeatedly until the water flows out scalding hot at the bottom. The soil is now sterilised, all spores of fungi or moss, or eggs of insects are killed, and the coming Fern spores have a fair field to start with. When the pot is cold scatter a tiny pinch of the spores evenly and as thinly as possible over the soil, recollecting that even this tiny pinch must inevitably mean far more Ferns than are wanted. Cover with a piece of glass, after putting in a numbered label agreeing with the register which you ought to keep, place the pot in a Wardian case or somewhere where it will not dry out or get worms into it, and leave it severely alone. We usually do several such pots at a time and bed them in fresh cocoanut fibre in a box or larger pan, covering the whole with one sheet of glass. This much simplifies matters and obviates risk of drought, as the fibre can be moistened from time to time in case of need without meddling with the pots. In a few weeks in the growing season a faint tinge of green will pervade the surface, and this will eventually grow into a mass of little green scales, which are what are called the "prothalli" or first stages of Fern life. If not too thickly sown these will grow to a quarter of an inch across, and by that time probably little fronds will be pushing up here and there amongst them, by which time the sowing may be chronicled as successful. If they are crowded, or previously if the sowing has been too thick and the scales are cramped, a larger pan should be prepared as before and sterilised with boiling water, and into this little patches may be pricked an inch apart. After the plants have appeared it is simply a question of more and more room, *i.e.*, pricking out again and again until they become individual established plants. Meanwhile the beginner will very likely have been puzzled by the appearance of wrong Ferns, *i.e.*, Ferns other than his register justifies the existence of, which is explained by the fact that Fern spores are carried some distance and settle on other Ferns, so that in sowing, however carefully, these alien spores get sown too. Meanwhile, the time for discoveries has arrived, as the distinctive characters show themselves, and these should be pricked out and kept separate, while—and this is important—inferior or defective ones should be ruthlessly thrown away. No selective cultivator is worth his salt whose heart is too tender in this respect; he must be a perfect Herod, and massacre the innocents remorselessly if he aims at a good collection. Some time since we saw a once choice collection in the Lake District, whose owner had died, after leaving a number of such innocents in his garden to see what they might turn out. Result: A wilderness of mongrels, which had completely choked out the good ones. Moral: If a Fern is defective in its first four or five fronds. Verdict: Dustheap.

ROCKERIES, FRAMES, &c.

THE natural habitats of most Ferns being broken, sloping, and more or less rocky ground, or the chinks and crevices in rocks, stone dykes, and old walls, it is as well, so far as may be possible, to imitate these conditions under culture, and to instal each species as nearly as may be in similar situations to those it occupies in a wild state. As these are indicated in each case hereafter in connection with the species, we need not specify them here, but merely point out the principles which should guide us in constructing rockeries, &c., for their accommodation.

With few exceptions, despite their need of water, Ferns grow in situations which are so far drained that no stagnancy occurs, and this must be borne in mind. To start a rockery, therefore, the soil of the site, if of a clayey nature, should be thoroughly opened up, and a liberal supply of old brick rubbish piled thereon as a foundation. Upon this a heap of leaf-mould and garden soil, about half and half, can be placed until the mound is nearly a foot higher than is required to admit of subsequent settlement, with a slope to the north or north-east, and, if possible, under the shelter of a wall facing north or trees on the south side sufficiently far away to prevent their roots monopolising the rockery. The mound being in shape, we may now proceed to face it with rude lumps of rock, the more porous the better, or, in default of rocks, with masses of shapeless brick waste, known as burrs, knocking all square corners off with a hammer if the bricks be too much in evidence. In arranging these lumps, begin at the borders of the mound, digging out a station for each with a trowel, and seeing that it beds itself firmly on its own centre of gravity, otherwise a frosty spell or even the settlement of the mound will lead to unwelcome disturbance after the Ferns are inserted. Use most of the largest burrs or rocks for the corner portions, and carefully avoid any formal arrangement As we proceed upwards we must leave space for the Ferns to be planted in, and arrange some of the remaining large pieces irregularly about to form somewhat overhanging shelters for such species as the Holly Fern and Parsley Fern, which much like to grow out of stations so protected. The rockery completed as regards construction, give it a thorough drenching, and let it settle down for a day or two. Then when the soil has become workable—*i.e.*, not sticky with wet—plant the Ferns carefully in the space left for them, digging out a spacious hole and spreading their roots close to or even under the burrs, which may be raised up for the purpose; the roots when outspread can have a trowelful or two of compost thrown over them, so that when the burr is let down into its place its possible roughness does no harm. In the small chinks the Spleenworts will be at home, and in the larger stations the other species must be arranged with due regard to size. Ferns requiring special soils should have stations dug out and filled accordingly.

Osmunda regalis, being a bog Fern, must have a peaty station near the bottom of the rockery; L. montana, a yellow loamy one, half-way up, and so on, while lime-loving Ferns, such as the Limestone Polypody and L. rigida, should have a spadeful of old mortar mixed with the soil in these stations. By attending to these little points a much more comprehensive selection can be grown successfully than if one and the same compost, irrespective of likes and dislikes, be used for all. The early spring is the best time of all for starting a rockery, but in point of fact it can be made at any season, provided care be taken to prevent drought killing the plants before they are properly established. For Ferns with travelling rootstocks, like the Polypodies, a fair space must be left, and in any case it is very unwise to fill the rockery at the outset with closely-planted Ferns. If they thrive they will speedily enough be shouldering one another for room, to the great detriment of their individual beauty, hence it is well to plant widely apart, and so defer this evil as long as possible. One other point is the advisability of planting single crowns instead of clumps. If you have clumps of several crowns, pull or cut them all apart, and either plant them separately or give all but one away, since, as already stated, the fronds and general development of a single crown Fern far and away excel those of a member of a crowd.

FRAMES.

For many of the medium-growing species, such as the Blechnums, Polypodies, Spleenworts, and Hart's-tongues, frame culture permits the formation of very charming groups where each species is kept to itself, and as the glass prevents much of that weather damage which is unavoidable in the open, such frames can be utilised for small growing delicate varieties of the larger species as well. As regards the frames themselves, any ordinary form with a sliding light suffices, but one 2½ feet high at back by 2 feet or 18 inches in front, according to depth, answers all purposes. A station drained as above, and provided with soil suitable to the species intended to be grown, must be made the size of the frame, which is then simply set on, with the light sloping to the north or north-east, and here again it is well if the midday or early afternoon sun be warded off by a wall or trees. If not, a movable blind is requisite. When the frame is well protected from the sun, the sides of it may be profitably utilised by nailing 6-inch slips of wood at an angle of 45° along them so as to form troughs, or, better still, a few galvanised iron brackets screwed on at the same angle will support 6-inch ridge slates used for roofs to form imperishable troughs of the same size. These being drained and filled with good soil are extremely handy for young seedlings, and take up practically no room. The planting of these frames is a simple matter, and if desired pots can be sunk in the soil as well, though it must not be forgotten that the roots are very apt to penetrate the soil and get broken off if the pots be shifted. Also, bear in mind the warning about close planting; it is not a jungle which is wanted, but rows of pretty plants with unhindered development of their individual variations.

WARDIAN CASES AND BELL GLASSES.

WARDIAN cases, with which may be classed bell glasses, are practically indoor frames, and the same remarks as to drainage and protection from hot sun apply. To secure such drainage in these cases, the zinc-lined receptacle for soil has usually an outlet provided with a tap, and the first thing to do when preparing the case is to place plenty of pieces of broken pots in the bottom of it in an open layer 2 inches deep, rough peat or fibry moss should be scattered over this, and the receptacle then filled and heaped with peaty, loamy compost, well lightened with silver sand. The surface may subsequently, and with advantage, be converted into a miniature rockery, in the chinks of which small growing species, such as the Spleenworts, dwarf Hart's-tongues, &c., will do well. The Filmy Ferns are, however, best of all for case culture, as especially referred to elsewhere. In any case, a good north light is requisite, and plenty of it, since without a sufficiency of this vital item the Ferns are sure to get drawn up and lose both health and beauty. Ferns in cases or bell-glasses arranged on like lines require very little watering, since the moisture condenses on the glass, and, running down, returns to the soil. If no gas be used it is well—for all Ferns but Filmies to give a fair amount of ventilation, and in any event care must be taken that the soil does not become sodden and sour through retention of stagnant water. Very pretty effects can be obtained by simply bedding small Ferns in pots in cocoanut fibre instead of planting into soil, this plan permits of shifting from time to time as growth proceeds. Wardian cases also form perfectly congenial nurseries for young Ferns of all sorts, from the beginning of their existence until they outgrow their room.

FERNS FOR SHADY GARDENS.

NATURE, in the process of evolution and adaptation of the innumerable forms of life to equally innumerable different conditions, has practically divided the vegetable world into two broad classes—sun-lovers and shade-lovers. This fact is too often lost sight of in connection with our gardens, which, artificial as most of them are to a certain extent, and similar to each other in their limitation between formal walls and even by surrounding buildings, nevertheless are found to vary very widely as regards the said points of sunny exposure and its opposite. The growth of trees and large shrubs, either in the garden itself or in the adjacent ones, materially affects this, and hence in a very large majority of gardens, especially suburban ones, we find the culture of flowers heavily handicapped by lack of sunshine and free access to the breeze, the result being eminently unsatisfactory, drawn-out, leggy specimens, unhealthy and vermin-eaten, and with very inferior bloom—if they bloom at all—disfiguring the garden instead of ornamenting it. Obviously, however, this very drawback to sun-loving flowering plants constitutes an opportunity f r the Fern lover, and in this connection it is well to remember that Nature has provided other forms of beauty than mere brilliancy of colour, and that after a feast of this the appreciative eye turns with restful satisfaction to the contemplation of the delicate tracery of verdant foliage, especially if this foliage be replete with diverse fashioning and feathery grace, such as the Fern world presents in surpassing degree. Travellers of botanical tastes in the tropical, sub-tropical, and warmer temperate regions of the world invariably dwell with delight upon the Fern-clad valleys, glens, and ravines which they find on the higher levels of the mountain districts, and in these days of photography we are most of us familiar with the ravishing aspect of Antipodean Fern paradises, in which huge Tree Ferns and their kin, grading down into the moss-like tiny growths of the filmy Fern tribe and their allies, the Selaginellas and Mosses, fill the entire field of view, losing absolutely nothing in beauty by their exclusiveness. Even in our Ferny glens of Devon, Cornwall, and many other of our western counties and those of Ireland, we find fair approaches to such perfection, since although our native Ferns cannot aspire—except in a few cases under special treatment—to the dignity of the Tree Fern, they have even in their normal or common forms a marvellous delicacy under such congenial conditions, and a sufficient diversity of size and make to obviate monotony. When, therefore, to this initial charm we are enabled to add, by their sportive capacity, the additional charm of an infinite variety, it is clear that we have abundant material in our native species for decorating our shady gardens to great advantage. Everywhere where walls or adjacent trees exclude the sun for the major part of the day, and especially where other walls or umbrageous growths "temper the wind" to their delicate frondage, we have conditions akin to those reigning in the Ferny dells aforesaid. The chief lack will probably be the atmospheric humidity and the moisture in the soil which characterises the Fern paradise proper; but even in this respect the season must be dry indeed when established Fern plants cannot hold their own in shady aspects, and the Fern lover would be but a poor wooer who would not take the trouble to remedy a possible lack by judicious watering. In this connection, however, we much deprecate the lavish use of the hose, since frequent watering overhead is apt to do damage, and it is much better to apply the water to the soil alone and leave the more congenial, because usually warmer raindrops to give the bath, which after dusty and dry weather is certainly beneficial. Another point in this respect is that many of the best varieties bear very heavy and dense tassels, which when suddenly saturated with water become too heavy for the stalks to sustain, and consequently breakage results, which even a heavy thunder shower would be less likely to cause, since the addition, after all, is by a few drops at a time, and does not resemble the sudden and violent drenching imparted by the use of a hose or watering-can.

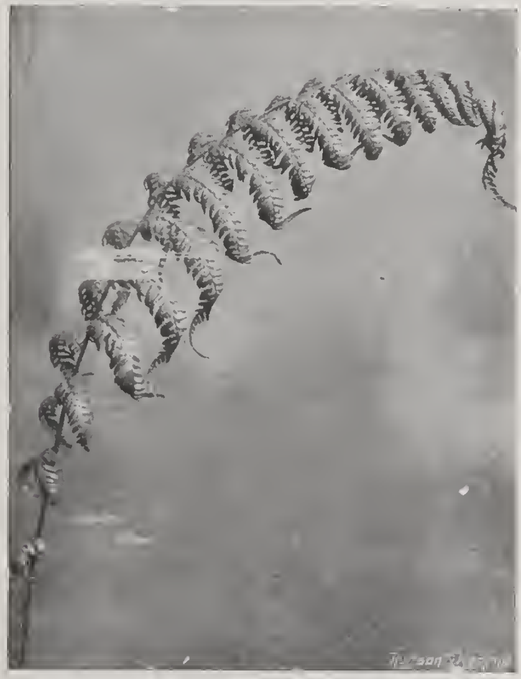
Elsewhere we have given a few hints as to the formation of rockeries, which undoubtedly imitate natural conditions better than the ordinary flat garden beds; it is not, however, absolutely essential to take this trouble, and we have seen very beautiful collections planted out under a north wall under such conditions and doing capitally. We have, indeed, in our mind's eye an entire garden, laid out in prettily shaped beds, which was a perfect picture throughout the summer, though it contained not a single flowering plant, its occupants being entirely hardy Fern varieties, judiciously selected as regards size and habit, and planted out at such distances that each had plenty of elbow room and scope for displaying its full character. This, indeed, is one of the secrets of artistic success; in the vast majority of cases plants are far too much crowded to admit of their individual charms being fairly developed and seen. It is, however, by no means necessary to confine these shady or half-shady spots to Ferns alone, they can be associated with advantage with many of the earlier spring bulbs, such as Scillas, Chionodoxa, Winter Aconites, Tulips, and such of the Daffodil family as do not retain their foliage too far into the growing season of the Ferns. In this way much of the bareness of the early spring among the deciduous

AN OUTDOOR FERNERY.

Ferns is alleviated while the bulb foliage ripens off, and can be removed precisely at the time when the new growth of the Ferns asserts itself, and in the interim a harvest of floral beauty will have been reaped by the appreciative eye.

Apart from the garden proper and its parterres, almost every shrubbery presents congenial conditions for Fern culture. As an example of this we may instance the Rhododendron dell in Kew Gardens, to which spot a number of British Ferns, normal and varietal, have been removed from the general collection, and are doing splendidly, filling up the gaps between the specimens with delicate foliage, which forms a charming foil to the dark leathery leafage of the Rhododendrons themselves, while revelling in the shelter from sun and wind which their robuster associates afford. In such positions the evergreen species, especially the Shield Ferns (Polystichum) and Hart's-tongues (Scolopendrium) would be peculiarly at home. In exposed positions, although their fronds are properly quite evergreen, they get very shabby during the winter, owing to stress of weather, but when so sheltered they remain quite presentable until the new growth arises. The deciduous Ferns, such as the Lady Ferns, some of the Lastreas, the Oak and Beech Fern, Osmunda regalis (Royal Fern), and others lose their fronds entirely in the autumn, and in some situations this point is an advantage where winter neatness is desirable, since the dead fronds can be removed in the autumn and the crowns neatly protected by a mulching of leaf-mould or dead leaves. Very old walls in many gardens, if well shaded, may well be utilised by the insertion of small plants of the Spleenwort family, and of the common Polypody and its varieties in deep chinks, near or under a coping, if such exist, it would even pay to lift a few of the top bricks and bed the little plants with a handful of leaf-mould beneath them. On the sunny side Ceterach would be at home, always provided the Fern Vandal were debarred access.

The installation of a good collection is therefore obviously easily practicable in many gardens, and would undoubtedly constitute a great source of enjoyment to its possessor. From March onwards to October there is a constant fund of interest, the varied modes in which the fronds develop at the outset is a striking feature, one and all possess the peculiarity of rising in little spiral coils, at once a distinctive feature of the Fern family, since no flowering plant does the like. No sooner, however, do they begin to show their stalks and to unfold the coil than each species adopts a style of its own, the male Fern, for instance, simply loosens it and drops it in front of the stalk like a long hook with the point turned inwards; the Lady Fern first becomes a loosened ball and develop sits side divisions more fully prior to developing a somewhat similar hook ; the Shield Fern, in addition to its young fronds being clothed with snow-white glistening scales, turns its coil right over backwards, inside out as it were, the stalk gradually stiffening and straightening as it develops ; in the Mountain Lastrea (L. montana) the ball-like top maintains its roundness and is beset with the bristling points of its side divisions, sticking out like Magog's spiky weapon ; while the little Oak Fern hangs out a miniature edition of the pawnbroker's sign as a preliminary to forming its tripartite fronds. Then, too, as the varietal characters of tassel and plume develop the interest of the Fern lover develops as well, while if he or she has attained the status of a Fern finder or raiser of new forms, the watching of the fresh growth on perhaps quite new lines affords a pleasure, the intensity of which can only be conceived by those who have experienced it. All this proves, we think, abundantly enough that the possessor of a shady garden who has fallen into an abyss of despair owing to repeated floricultural failures, has only to try his hand with more fitting denizens of his little domain to be well rewarded.



Athyrium filix-fœmina var. revolvens (Druery).

FERNS IN ROOMS.

THE culture of Ferns, and, indeed, of any other class of plants in dwelling-houses is, as a rule, a failure, the specimens seen, unless freshly brought in from a nursery or conservatory, being usually more or less unhealthy—generally more—and consequently unsightly, so that their primary purpose in such places—*i.e.*, decoration—is frequently frustrated. The reason of such failure is not far to seek, since the most essential factors of plant life are generally ignored. These are light, water, and pure air. As regards the light, practically the only place fit for plants in an ordinary room is immediately next the window, and yet we find plants in pots standing on tables in the centre of the room, and sometimes on stands in distant corners, whither nothing more than a glimpse of daylight is obtained, and a sight of the blue sky—a flower's proper roofing—is never enjoyed. Any growth made under such conditions is inevitably spindly and drawn, and flowering is all but impossible. The proper watering, the next essential, is only exceptionally attended to, and we are as likely as not to find the soil either dust dry and hard as a brick, or else the pot, being stood in a saucer or vase, is supersaturated with stagnant water, both conditions being equally fatal as a rule. Finally, room plants have often to contend with impure air induced by the use of gas, which in its combustion gives off a very small percentage of sulphurous acid, a deadly plant poison, which scarcely any plant but the cast-iron Aspidistras can withstand for any length of time. Having made these preliminary remarks on room plants in general, we return to our main theme, by pointing out that Ferns being contented with shady conditions are obviously better fitted for room culture than flowering plants, although as regards proper watering and non-poisonous air they are quite as exacting. It will repay us, therefore, to consider a little the principles which underlie success. Light, as we have seen, is one main essential. Under its influence leaves or fronds build up their own substance, and that of their flowers or seeds or spores, as the case may be. This being so, all the leafy surfaces as they grow spread themselves out at precisely such an angle as to gather as much light as possible. During the period of growth this process is constantly going on, and both leaves and fronds are endowed in their young state with a capacity for adjusting themselves more or less in the right direction. The frond tissues, however, are no sooner fully grown than they stiffen and lose this power. Bearing this in mind, we will imagine a pretty Fern in active growth, with a dozen rising fronds placed in a north window ; it is left undisturbed for several days, and has in that time spread its young frondage to the best advantage. Its owner then lifts it up to inspect it or show it admiringly to visitors, and having done this puts it back in its place with its window face turned towards the room. Half the length of the growing fronds has stiffened as aforesaid, the other half is open to readjustment, and completes its growth accordingly, unless meanwhile an additional " kink " is imparted by another shift. Result—twisted and distorted fronds, and an ugly Fern in lieu of a pretty one. This indiscriminate turning and shifting is the main cause of non-success in growing handsome specimens, and the proper cure for this is to insert a peg or label in the pot, and see that that is always retained in the same position. Plants *will* grow towards the light, and this fact must be recognised and put up with. Watering is always a problem with room plants, but here again Ferns can stand saturation better than other plants, and if the pots be well drained, or one pot be fitted into another, the use of a saucer avoids much risk of drought, and is little likely to do harm. Regularity is, however, a great thing, and Ferns, minus saucers, watered thoroughly every morning when in full growth are fairly sure to thrive. As regards gas fumes, plants in rooms where gas is burnt may be set on the floor at night with advantage, since in this position they run the minimum of risk.

As regards the class of Ferns best fitted for room decoration, the great bulk of those supplied by the trade are exotics, the consumption of which is enormous in view of the defective culture, or rather, the effective slaughter, involved in their usual treatment by the purchasers. It is safe to say that not one in ten thousand room Ferns is fit to be seen a month after purchase. Exotic Ferns are easily and rapidly raised from spores and propagated in other ways, and it is doubtless due to this fact and the consequent cheapness that the trade confines itself to them rather than to those native varieties which form our theme. Our hardy British Ferns not being amenable to forcing treatment, which they resent, take, as a rule, several years to develop into full-sized plants or saleable specimens, hence they are not so easily brought to market by the thousand, and, indeed, we should be sorry to see them subjected to the slaughter aforesaid, and only suggest their adoption to those who are prepared to study their natural needs, treat them common-sensibly, and, as a reward, be able to show, as the writer can, beautiful plants in prime condition, whose acquisition dates back a quarter of a century. As room and window plants, indeed, our hardy Ferns cannot be excelled, provided they are not turned about constantly like so many teetotums, and are not coddled for a week and left dry for a month, and so on. Among all the exotics, for instance, we have no range of dwarf gems, fifty of which could be accommodated in a single window. Our native Ferns vary so greatly in size as well as in fashion, that they admit of much greater choice. A number of the evergreen varieties keep in fine form through the winter, and do not demand, as exotics do, any protection from frost, while, as we have said, a pet plant may be made a pet of for one's lifetime.

It must, however, be understood that Ferns will not suit for sunny windows, in such positions flowering plants do well if rationally handled Windows with northern and eastern aspects alone are adapted for Fern culture, and even with these the dislike of Ferns for wind must be remembered, since to throw up a window and thus expose the Ferns adjacent to it to the consequent strong draught would be very apt to be detrimental.

A final advantage with British Ferns is that frequent repotting is not essential. If a full grown Fern remains healthy it may remain in the same pot for many years. We have one specimen Lady Fern which rises year after year in the most robust fashion, and yet for over twenty years it has remained in the same soil in a shallow half-round cork pocket, wired on to a roof slate. It does not even get an annual mulching of soil ; for a long time we have determined to see how long it will feed as it were, *a la* chameleon, for the pocket holds nothing now but a dense mat of roots.

Few people are aware what pretty specimen window plants even the common wayside Ferns will make if treated as above. We once saw a common Hart's-tongue which completely filled a good-sized window ; it was in a huge pot and evidently a very old plant, for it bore several scores of bright green fronds fully two feet long. We also noted in Guernsey a single plant of a finely tasselled Hart's-tongue, which took up the whole of a narrow window, though supported by a sort of trellis.

One thing is certain, and that is, that no one would revert to the common display of a dozen or so of exotic Pterises, all very much alike, after a fair experience with a collection of native varieties. They may cost a little more to acquire, but once acquired they last, as we have said, a lifetime.

A British Fernery. Mr. C. T. Druery's Collection.

FERN HUNTING.

In view of the immense number of varietal forms which our British species have assumed, and the fact that a very large proportion, numbering among them many of the finest, have originated in a wild state and been found by persons who have devoted their leisure to close inspection of the Ferns they have come across, or in rarer cases, altogether accidentally, we may well devote a short chapter to the consideration of this singular capacity for variation and the circumstances under which such sports are found. Judging by the results of Fern hunting in the British Isles as contrasted with the relative paucity of foreign finds, it would *primâ facie* appear that there must be a special something in the soil, climate, or general environment which leads to greater sportiveness, but as against this theory it must be borne in mind that in no other country has there sprung up a special taste for variety hunting, which, as here, has led to a considerable number of both sexes assiduously searching for new ones after having been inspired by distinct finds with that faith which is the best encouragement to perseverance. On the average many thousands of normal Ferns must pass beneath the scrutiny of the hunter or huntress (for ladies have been particularly fortunate) before a distinct sport presents itself, and obviously the first step necessary for a beginner is to acquire a thorough acquaintance with the normal forms, so that any departure is instantly noted and followed up by closer inspection. It very frequently happens that in a dense clump of rank-growing normals the merest tip of a frond or fronds indicates the presence therein of a variety, and it may even occur that one species may assume a varietal form closely resembling a different species of another shape and thus baffle the eye. Thus we have found two forms of Athyrium (Lady Fern), one which we named A. f. f. oreopteroides, so closely did it imitate the mountain Lastrea (L. oreopteris or montana) which grew in conjunction, and the other we took at a first glance for Lastrea dilatata, the fronds being quite triangular (A. f. f. deltoideum), especially as L. dilatata was abundant in the same spot. The texture alone determined the second look, which discriminated them as marked varieties. Both these would infallibly have been overlooked had not experience educated the eye to relatively minute differences.

Another point with reference to the greater number of British finds is that in many countries it is not so easy to hunt as here; the poking and prying and intrusion into the out-of-the-way nooks and corners which are liable to harbour good things, are all, it may be, attended with danger by harbouring bad ones, and we ourselves have still a vivid recollection of a fine rattlesnake in Mexico which turned up just beneath a lovely patch of Nothochlænas and Cheilanthes. Even here (in Ireland) we once let ourselves drop down the face of a rock to inspect a mass of Hymenophyllum, only to find a wasp's nest as big as one's head within 6 inches of our nose. Fortunately, by standing perfectly still, the disturbed swarm, after a chorus of buzzing, obviously took us for a fallen rock, and permitted us to glide gradually away unmolested. The main point, however, is that the explorer abroad is usually a general botanist on the look-out only for new species, and a general glance satisfying him as to the species, he passes on and does not pursue the individual investigation necessary to the variety hunter pure and simple. When, however, a man with an eye for varieties goes abroad, as did the late Mr. S. Brown, to the Azores, very fine varieties crop up, as, for example, Woodwardia radicans cristata, two grand crested varieties of L. dilatata and Asp. Hemionitis multifidum and cristatum, a form of which we ourselves also found recently when there, plus a finely crested Pteris aquilina. In the United States Ferns are so popular that a special "Fern Bulletin" is issued quarterly and a Fern chapter is instituted for the encouragement of research. Here, again, quite recently varieties have been found, and we are the happy possessor of Phegopteris hexagonoptera truncata, like a huge Beech Fern, with most tips squared and thorned, and Dennstaedtia punctilobula cristata, prettily tasselled, sent us by Mr. W. R. Maxon of the Smithsonian Institute, while fronds of a nicely crested Athyrium were sent us not long since by a lady there. These facts point, to our mind, to the conclusion that wherever Ferns are plentiful it only needs proper hunting to find varieties, and the keener and more persistent the hunter the more there will be found. Mr. J. Moly, for instance, resident in Dorset, discovered in the course of years no less than 600 distinct varieties, numbering among them many of our finest, mainly within the district, and Dr. Wills, his neighbour at Chard, found a very large number in addition. We cite these facts at length because they constitute an encouragement to anyone enjoying opportunities of search in Ferny districts. In the large majority of instances the "finds" are either solitary plants or clumps originating presumably from an originally single sport, though now and again, as might be expected, seedlings have established themselves near by, so that further search is rewarded by further specimens. Very rarely colonies, as it were, are found, as in our own case of Asp. ad. nigrum caudatum, where many yards of a stone dyke contained no other form but hundreds of this. A most remarkable case was recently brought before us, where. in Cornwall, three distinct finds of three distinct species were found in one clump in a wood, a tasselled Male Fern, a forky Shield Fern, and a splendid bipinnate form of the common Polypody—a rare case indeed, and probably unique. The

EQUIPMENT OF THE FERN HUNTER

is of the simplest; some carry a tin vasculum, which is so far good that it protects the fronds from injury; it, however, has the disadvantage, when one is clambering over the rough and precipitous ground so dear to Ferns, of swinging round and getting in the way, and personally we abjure anything but a strong trowel, a stout hooked stick, a cloth bag like a fish basket, which can be rolled up, a pocketful of old newspapers, and some string. A "find" discovered, we dig it up carefully by the roots, separate it from any associated common ones, wrap some moss or old fronds round the roots, envelop it in a sheet of paper, slip it into the bag, and sling this behind us by a string over our shoulders. At the first opportunity we dip the roots in water, and when we reach our temporary haven at the end of the day we instal it in a box with a good supply of fresh wet moss, and place this in a cool shady place. The Fern is then good for a fortnight or more, until finally installed at home. Puzzles, of course, crop up in such expeditions; "finds" sometimes occur in awkward places, are seen at the top of a high wall far out of reach, or in hedges where the tree roots almost require dynamite to liberate the Fern, or, as in one of our experiences, it may be so huge as to need two men and a horse and cart for dislodgment and conveyance, or, finally, as in the case of that beautiful Fern P. v. Prestoni, it may be seated so deep in a rock chink that the finder had to roll the rock itself across country and actually grow the Fern out of its hermitage at home. We, however, only know of one case which baffled the enthusiast, a charming Lady Fern, growing in a deep drain, in the mouth of which, at the base of a massive stone dyke, the merest tips of the fronds had reached the light with the roots under the dyke and on the inaccessible other side of it. We nearly suffered such a catastrophe ourselves once, finding a beautifully crested L. dilatata in a close preserve bristling with threats of prosecution of Fern robbers. Here, however, the Fern itself saved the situation by bearing ripe spores, and thus, though left practically intact, eventually decked our fernery with true progeny.

It may also be pointed out in connection with Fern hunting, that even if something specially good fails to reward the hunter or huntress, the favourite habitats of Ferns are invariably in picturesque localities, and hence a day's outing means not merely a day's search, but also a ramble among the greenest of lanes or over and through the fairest of hills and glens, where Nature is at her loveliest. Hence, in any case, there is the enjoyment of fresh air and exercise amid charming surroundings, and in addition, if success crowns the day's quest with anything distinct enough to form a souvenir, to say nothing of something entirely new, it is in our opinion difficult to indicate a more satisfactory way of spending a holiday. We must, however, point out that there is a vast difference between the variety hunting we advocate and that adopted by too many tourists and holiday makers, who simply hunt the species, and by rooting it ruthlessly up wherever discovered have entirely depleted many Ferny spots of their erewhile feathery denizens. In the autumn it is painful to see the baskets and hampers of wayside Ferns which the visitors to these habitats are bringing away, not one in a thousand of which in all probability will ever be properly cared for. The variety hunter, on the other hand, finds a solitary plant of singular beauty, and by removing, cultivating, and propagating it, eventually multiplies it so that every collector may boast a specimen. In this way he enriches the world, instead of, as Shirley Hibberd puts it in this connection, "skinning the planet."

However, we have now said enough, we think, to show that Fern hunting is not without its adventures as well as its rewards, and with the final remark that the occurrence of varieties is too wayward and capricious to permit as yet any definite information to be given as regards the likeliest places, we will simply conclude by recommending our readers to try their hand the first opportunity, and expressing the hope that success may inoculate them with that lasting and incurable disease known as the "Fern fever."

FERN CROSSING AND HYBRIDISING.*

THE absolutely microscopic nature of the organs which, in Ferns, perform the part of flowers renders their systematic crossing or hybridising an extremely difficult matter, and, humanly speaking, it is impossible to proceed with two Ferns with the same certainty of knowledge that the preliminary steps are sure and indubitable, as the florist can with two distinct flowers. In the one case he deals with something he can see and handle: he can take his scissors and remove the stamens before the pollen is ripe, and in other ways secure a virgin flower on the one hand, while to remove the pollen from another set of stamens on another plant is the simplest matter imaginable. With both individuals he starts on a clear and definite basis, and with ordinary precautions against intrusive insects, &c. can practically swear when the seed-pod swells that it contains A plus B. With the Fern, however, it is quite another matter. Even though we gather a fertile frond of a known variety, and isolate it by placing it between clean paper in the dwelling-house, the chance of stray spores from other Ferns having been shed upon that frond beforehand is always existent. Uncertainty No. 1. Assuming, however, that a pure culture is obtained, the prothalli grow profusely and healthily, but when their time for fruition is near we can only discern, and that moreover upon their undersides, even with a good lens, a number of tiny pimples, some spherical and some oblong. A pin's head would accommodate a dozen of either sort. Within the round ones are packed a score or two of little tadpole-shaped organisms, only visible under a high-powered miscroscope ; and at the bottom of the oblong ones is an embryo seed a few degrees bigger. These are the elements the Fern crosser has to deal with, and to carry out his ideal he should carefully lift one of these tadpole bodies just when it bursts its round-headed container and starts on its wedding journey across the ocean of a dewdrop, and then carefully convey it to another and distant bride selected for it, in lieu of the maiden close at hand. Meanwhile it is fairly certain that that other bride has many other suitors, and the new one may consequently arrive the day after the wedding, when, of course, the match-maker is frustrated. He is frustrated, but how is he to know it? To come back to botanical phraseology, he may even have isolated the archegonium of

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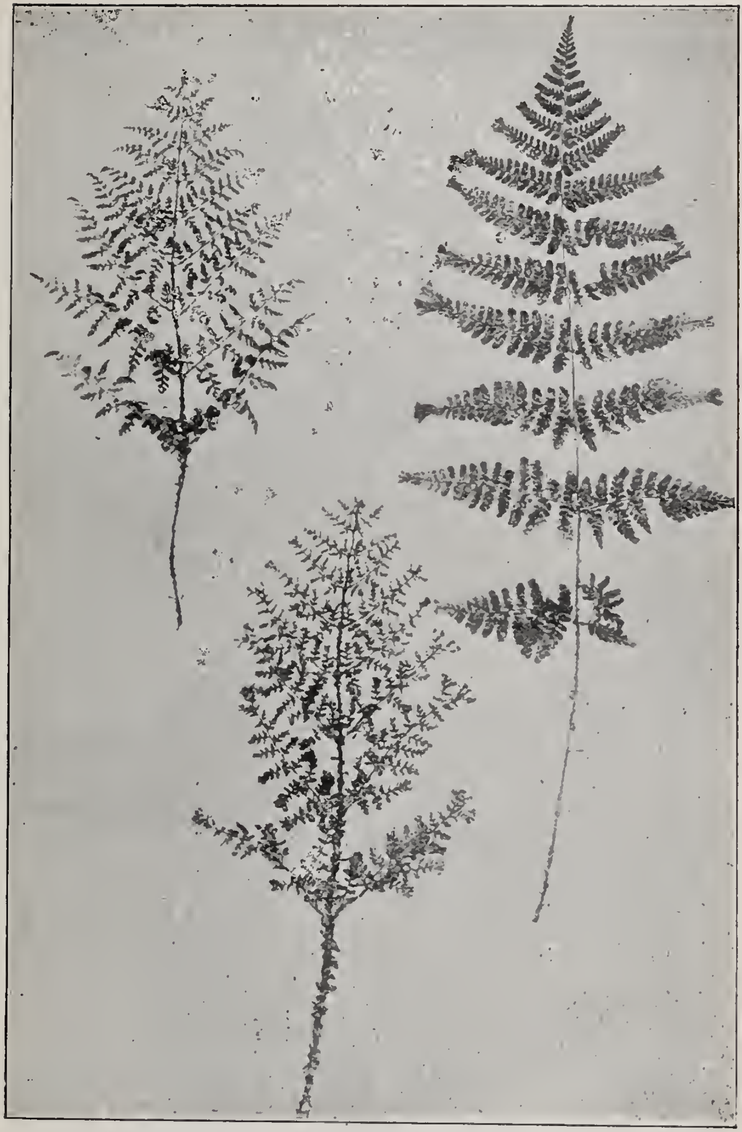
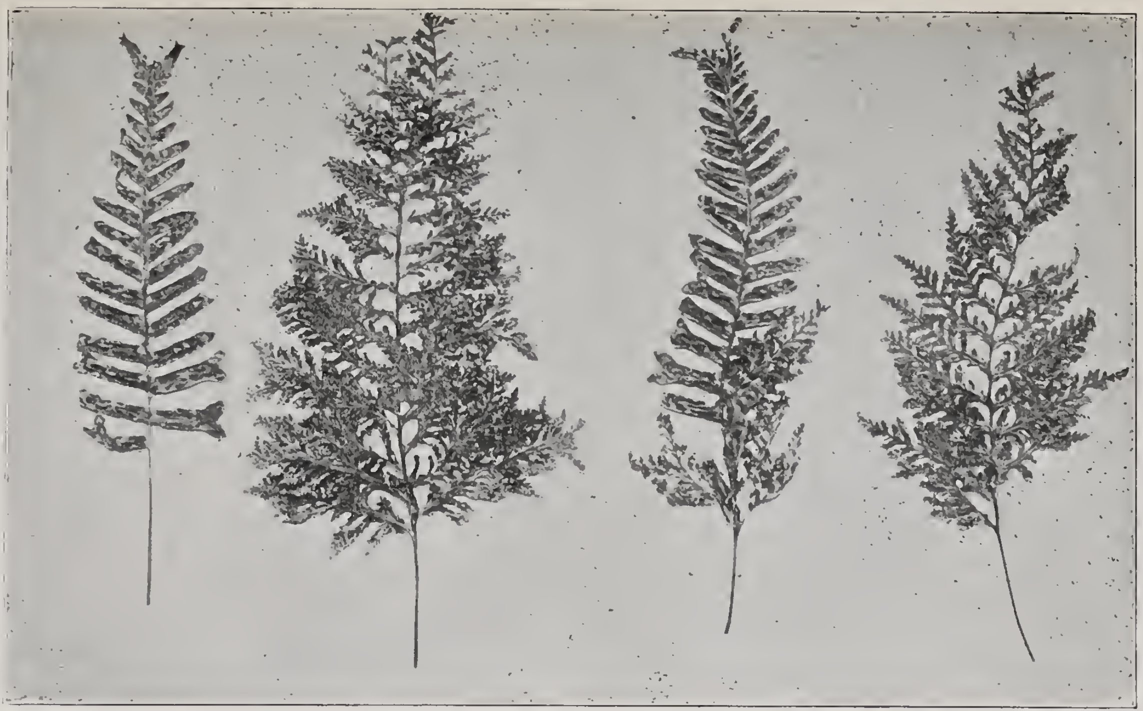
* Paper read at Hybrid Conference of Royal Horticultural Society.



Lastrea dilatata lepidota (A) × L. d. cristata (B)
L. d. lepidota-cristata (A + B) Stansfield.

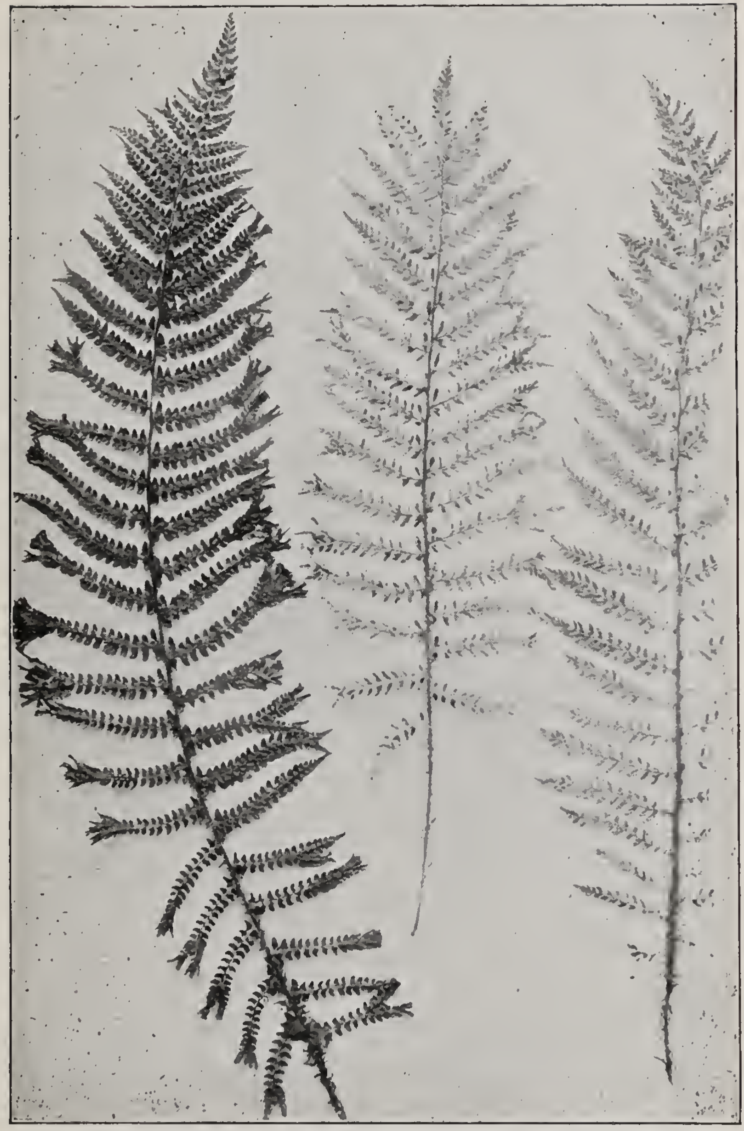
one prothallus by severance, but as there is no doubt whatever that cross-fertilisation occurs through the myriad tiny insects that are invariably present, even then there is a risk, and in fact the risks, difficulties, and uncertainties are practically so unavoidable that a different method altogether is compulsorily adopted. The usual course when a cross between two distinct Ferns is desired is simply to collect the spores of each as carefully as possible with a view to eliminate strays, and then either to mix them intimately before sowing, which is the better plan, or sow them one after another rather thickly in the same pan. By this means a proportion of the distinct spores are bound to germinate in such close juxtaposition as to cause more or less overlapping when the prothalli develop, and obviously we thus produce conditions favourable to cross-fertilisation, especially if at the proper time, that is just before the prothalli are full size, we produce a small inundation, either by immersing the pan until the water percolates through the soil, and just submerges the undersides of the prothalli, or by watering overhead, which is less to be commended. My own idea of the best way is that the pan should be placed in warm water, say about 70 degrees or so, and when the prothalli are reached by the rising water to let them stand thus for half an hour or more, so that, stimulated by the warmth and wet, a large number of the ripe antheridia may burst, when their contents would naturally, in the prevailing flood, find their way in all directions, and certainly afford the maximum of chances for foreign alliances. Shorter immersion would reduce these, and a mere dip and out again would carry the bulk of the free antherozoids into the soil before they had a chance to wander. The above suggestions as to sowing together for a cross apply necessarily to such varieties or such species as arrive at the fruition stage in their prothalli about the same time. Ferns, however, vary greatly in this respect; some bear spores which germinate at once and arrive at maturity at a time when others have only begun to form prothalli. Obviously with such ferns a cross can only be arrived at either by sowing the slow one thinly much earlier than the other, and subsequently sowing in the same pan, the rapid grower broadcast among the other existing prothalli, or by pricking out patches from separate sowings which have arrived at maturity and placing these closely together in a pan by themselves in the hope that subsequent flooding or other means of transfer may lead to the desired results. The former course is clearly preferable if the cultivator is sufficiently acquainted with the relative sluggishness or activity to be able to calculate when to sow the second crop.



POLYPODIUM VULGARE BIFIDO-CRISTATUM (A) × P. V. ELEGANTISSIMUM (B).
P. V. ELEGANTISSIMO-CRISTATUM (A + B).
C shows a frond of the cross A + B reverting to one of the parents A, and not to the normal form.

Finally there has been put forward as a theoretical possibility the following plan. The archegonia, or seed-vessels, are as a rule situated just within the indentation of the heart-shaped prothallus, and the antheridia or equivalents of pollen masses among the root-hairs covering the larger and other half of the prothallus. The prothallus is most retentive of life, and will bear with impunity almost any amount of cutting up. We will therefore suppose two pans of thinly sown spores, each one of a different variety or species; as soon as the prothalli are half grown, *i.e.*, before any fertilisation is likely, we take a keen razor and cut each prothallus across just below the indentation. We do this in both pans, carefully removing the male halves in each and neatly embedding them in the soil, just touching the archegonial portions of the other variety or species which have been left *in situ*, and which if deprived of root-hairs by the operation will certainly develop more if gently pressed into the soil and kept close. In this way the chances of self-fertilisation would be reduced to a minimum, and those of a cross increased to a maximum, as the subsequent growth of both halves would bring them into extremely close juxtaposition. There is, however, a good deal of irregularity in the arrangements of the organs on the prothallus, and hence this sort of division cannot be depended upon absolutely as separating the sexes.

Having said so much (or so little) of the *modus operandi*, we may now glance at the results already obtained, namely, by simply sowing together and trusting to chance for the results. To Mr. E. J. Lowe must certainly be accorded the merits of the first most striking hybrid, viz., that effected by him between a cruciate form of Polystichum angulare and a dense form of P. aculeatum, the result being a cruciate aculeatum, and I may here remark that it is only where absolutely distinct forms such as these are crossed that we can be sure that the progeny is a cross at all, because once a Fern or other plant has broken away from the normal plan of growth, its progeny is apt to vary again, probably more or less on the same lines, but not necessarily so. Fortunately, however, numerous crosses have been effected under circumstances of choice which eliminate this doubt. Mr. Clapham, for instance, sowed the finely cut form of Polypodium vulgare, known as elegantissimum, with another form known as P. v. bifido-cristatum, an attenuate crested form. Elegantissimum has a peculiar knack of partial reversion to the normal. The offspring of the cross was not merely a more or less tasselled form of elegantissimum, which might have been a secondary sport *per se,* but when it tried to get back to normality it produced a frond of the true type



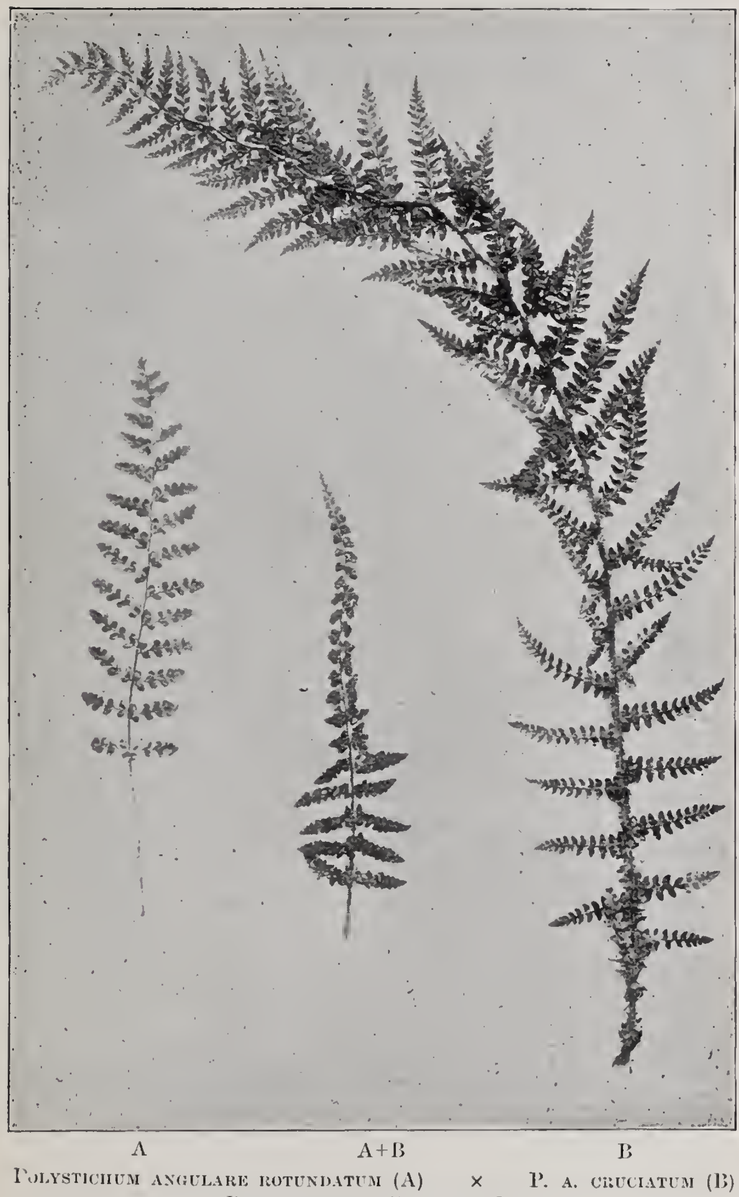
Polystichum angulare polydactylum (B) × P. a. lineare (A).
Result of the Cross (A+B).
The × marks indicate defects in parent and progeny.

of bifido-cristatum. The illustration on page 19 shows fronds of both parents and of the result of their union.

Mr. Schneider, in his marvellous hybrid (the most striking yet produced, to my mind) between this same elegantissimum and the huge exotic Phlebodium aureum, finds the hybridism confirmed by precisely the same character of partial reversion. In another cross between Athyrium filix fœmina Victoriæ, the most remarkable Fern yet found, bearing percruciate and tasselled fronds, and A. f. f. setigerum with translucent, bristly excrescences all over it, the result is A. f. f. Victoriæ, true to type, but bristling throughout with the setigerum character. Crosses and hybrids of this class bear their certificates of origin upon their fronts: in each case the parents are pure-bred original finds, and in their offspring the strong parental marks are distinctly brought out. At Kew there are a great number of marked instances among the Polystichums raised by Colonel Jones and others by crossing his polydactylous find of P. angulare with many other varieties. In this Fern there must have been some special prepotency, for the crosses were innumerable, but in every one that I have seen as yet they are ear-marked by the parental defect of producing here and there non-polydactylous divisions and irregular furcation to boot. One and all present this feature, which establishes the dual origin convincingly, but spoils the plants. The plate on page 21 shows fronds of one of these crosses as typical of all, the × marks indicating the defects.

Among hybrids between species, I must not omit to mention Mr. Lowe's indubitable cross between Scolopendrium vulgare and Ceterach officinarum. As will be seen from the fronds of it exhibited, they are of Ceterach pinnation, though confluent at the tip and quite scaleless, while the fructification can be detected on the basal pinnæ as in faced pairs, *i.e.*, Scolopendrium fashion, and further up, as single lines, *i.e.*, in the character of the Spleenworts. I do not know whether this plant is still alive, but the fronds shown establish its hybrid character and determine both parents with certainty. I invite particular attention to this exhibit, as I fear it constitutes all the evidence existing, and I should like it to be confirmed by others. In "European Ferns," page 137, a presumed natural hybrid between the same two species is figured, but considering the great varietal capacity of Scol. vulgare, and the existence of numerous pinnatifid forms, the hybridism in that case is, to my mind, extremely doubtful.

Having thus cited a few of the conclusive evidences of the possibility of crossing, not merely varieties but also widely different species, and given a few hints as to the *modus operandi*, the next thing is to give some idea of the directions in which

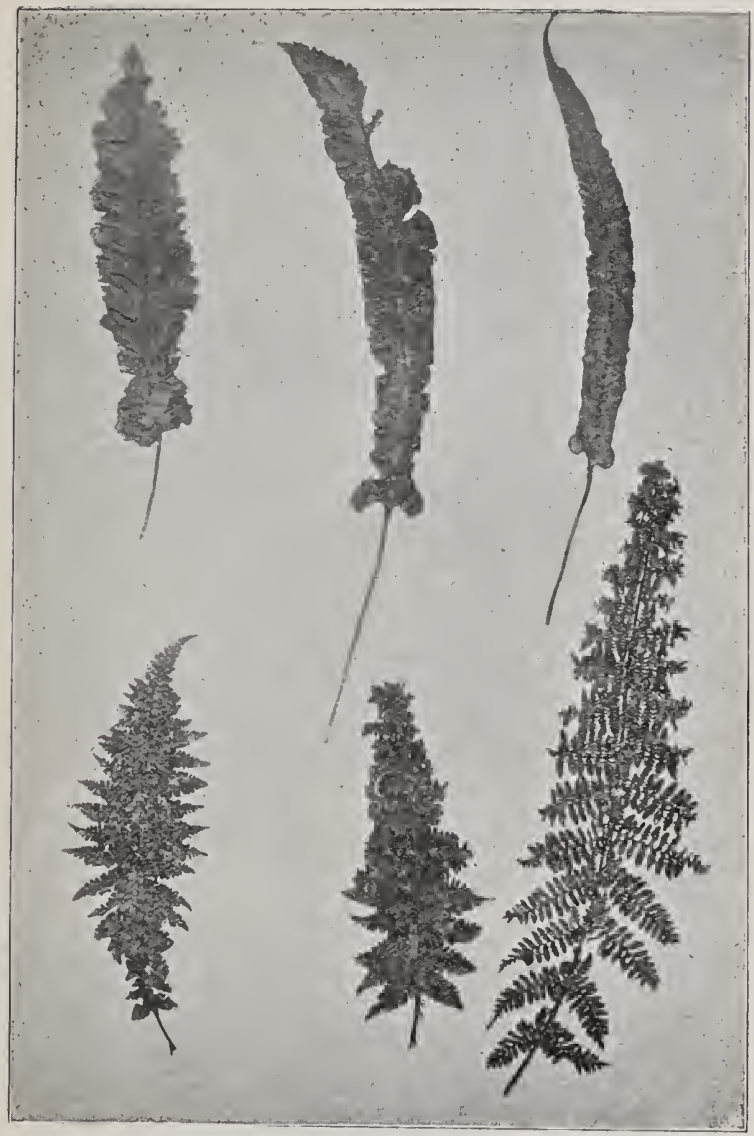


A A+B B

POLYSTICHUM ANGULARE ROTUNDATUM (A) × P. A. CRUCIATUM (B)
RESULT OF THE CROSS (A+B).

Note that only the upper half of B is cruciate, and so with A+B.

this possibility may be utilised to the best advantage. Polypodium Schneiderii is, I think, eloquent with two possibilities of extreme value. The one is that of enhancing the simple beauty of many exotics by alliances with the highly ornate forms which our British hardy species have assumed, both under purely natural conditions as wild finds and under selective culture of the progeny which they have yielded. The other is the increased capacity of exotics, so hybridised, to withstand low temperature, due to the infusion of hardy blood. In Ferns, thanks to the curious fact that the prothallus, or green scale upon which the flower homologues are produced, is almost constant in size throughout all species except the Filmies, the minutest species and the largest Tree Fern commence their career under practically identical conditions, and crossing and hybridisation therefore are not limited as in flowers by incompatibilities between length of stigma and size of pollen. Hence, so far as size is concerned, there is no bar, and the smallest may be allied with the largest if specific or generic differences be not too great. Consequently, though our British Spleenworts are all of comparatively small growth, their varietal forms may presumably be imparted to many of the grand large-growing exotics, and the task is the better worth attempting, as the genus is peculiarly exempt from the tendency to form tasselled or crested varieties, though examples of such occur among our native species, and thus afford fair starting-points for hybridising purposes. Scolopendrium vulgare, curiously enough, though extremely closely allied to the Asplenia, and capable, as we have seen, of a definite alliance with them, is, on the other hand, one of the most variable Ferns in the world, and hence, taking the varieties of this species and the tasselled forms of Asplenium trichomanes and A. adiantum nigrum, I would suggest systematic admixtures of the spores of these with a number of the plain-fronted exotic Asplenia, and particularly with A. nidus avis. This last has recently given us one curious wild semi-cristate sport, A. n. a. multilobatum, indicating great capacity for variation; and considering its extremely close agreement in structure with Scol. vulgare and the alliance above cited of this latter with Asp. ceterach, I feel confident that with perseverance we might not only obtain handsomely tasselled Bird's-nest Ferns, but also, in conjunction with some of the fertile forms of S. v. crispum, frilled ones as well. That beautiful Hart's-tongue, for instance, S. v. laceratum, with broad sagittate, tasselled basal lobes, deeply cut pinnatifid fronds, tasselled heavily at their terminals, would be a splendid mate, and the hybridist who mated the twain would certainly not repent the trouble taken. This field is a very wide one,



Upper half: Scolopendrium vulgare crispum fertile (A) × S. v. muricatum (B).
Result of Cross (A + B).

Lower half: Athyrium filix fœmina congestum (A) × A. f. f. excurrens (B).
Result of Cross (A + B).

but care would have to be taken to avoid all but thoroughbred symmetrical forms, since faults are almost certain to be transmitted and the progeny marred.

Asplenium trichomanes has, so far as I know, never yet been crossed or hybridised. A. t. confluens, Stabler, an asserted hybrid with A. marinum, does not bear the test of investigation, as A. marinum did not grow near the locality of origin; and although its spores are always imperfect, this is not enough to establish hybridity by itself. A. trichomanes cristatum, however, would be well worth sowing with other Asplenia, many of which are obviously very closely allied indeed. Our Blechnum spicant has given us some charming forms, crested, dissected, and otherwise varied. B. s. cristatum, B. s. ramosum, Kinahan, B. s. trinerviocoronans, Barnes B. s. concinnum, Druery (strings of emerald scallop shells), B. s. plumosum, Airey, and others, one and all might find fit mates among exotic Blechnums and Lomarias, to many of which new charms would certainly be imparted, the twofold character of the fertile and barren fronds emphasising greatly the varietal features. Our Lastreas or Nephrodiums and the exotic ones afford another field for combination, as well as our marvellous Polystichums, of which the best plumose divisilobes are often sufficiently fertile to afford material. P. setosum especially should be tried with some of the best. Could thorough alliances be effected between this lovely lucent hard-fronded evergreen Shield Fern and such gems as P. a. cristatum (Wollaston No. 10), P. a. cristato-gracile, Moly, and some of the divisilobe plumosums of Jones and Fox, Pearson and Esplan, the results could only be gems of first water. Then there are our Osmunda regalis and Osmunda japonica cristata to act as suitors to O. cinnamonea, O. interrupta, and O. gracilis, and finally there are our lovely forms of Polypodium vulgare, P. v. cristatum, grandiceps, Fox, Forster, and Parker, bifido-cristatum, and pulcherrimum, to say nothing of P. v. elegantissimum, the British-born parent of P. Schneiderii, all waiting for chances of the introduction which they certainly merit to the aristocratic Fern circles of their more stately foreign relatives. The field indeed is all but virgin, and I am confident that careful cultivation of it would yield a host of new and charming novelties, provided—always provided—that it be done on right lines.

Into the question of simple crosses between varieties I do not propose to enter, space prohibiting, though to me and to British Fern specialists generally there is a wide and fertile field still but partly cultivated. I have, however, framed my paper rather for the benefit of the more numerous raisers of exotics, who are too apt to ignore the merits of our home Ferns altogether, and only here and there recognise their value in the direction I have endeavoured to indicate.

In conclusion I may mention that there is one point in connection with Fern crossing which has no parallel in flowering plants, and that is the possibility of attempts being frustrated by apogamy. In numerous Ferns it has been found that the young plants are asexually generated in the prothallus, a simple bud arising on the spot usually occupied by archegonia. Pteris cretica, Lastrea pseudo-mas cristata, Cyrtomium falcatum, and others present this peculiarity in nearly every case, and of course under such circumstances no crossing is possible, unless in exceptional cases, where the normal process may obtain. As Cyrtomium and Lastrea, for instance, are closely related, and no crested Cyrtomium has been found, I sowed Cyrtomium falcatum and C. Fortuneii thickly with L. p.-mas cristata, obtaining a pure crop of both, a result I should have expected had I not forgotten the apogamous character of both members of the desired alliance. This, then, constitutes a hidden hindrance peculiar to Fern crossing. There are, however, a number of varieties of Lastrea p.-mas which afford extremely strong evidence of crossing, and I am therefore inclined to believe that apogamy in the species is by no means without exceptions, and that normal sexual reproduction frequently occurs.

Thanks to Mr. Alex. Wright, of South Norwood, I am able to present photographs of several of the crosses exhibited, viz.:

Lastrea dil. lepidota × L. d. cristata. (Page 25.)

Polypodium vulgare, var. bifido-cristatum × P. v. var. elegantissimum. (Page 27.)

Polystichum angulare, var. polydactyla × P. ang. lineare. N.B.—In this cross the defective polydactylism alluded to in the paper is seen and indicated by crosses. (Page 29.)

P. angulare, var. rotundatum × P. ang. cruciatum. N.B.—The rounded pinnules are not well shown in the photograph, but the normal outline of the lower part of the cruciate parent is preserved clearly in the cross. (Page 31.)

Scol. vulg. var. crispum fertile × S. v. muricatum. Result, a muricate crispum. Athyrium filix fœmina, var. congestum × A. f. f. var. excurrens Result, a congested excurrens; a very striking cross; the hair-like terminal points of B and of A + B are hardly visible in the illustration. (Page 33.)

ADIANTUM CAPILLUS—VENERIS (THE MAIDEN-HAIR FERN).

In this solitary hardy member of a large family we have as it were a warm-blooded exotic which can only tolerate our climate under specially favourable circumstances, in point of fact it is far more tender than many exclusively exotic Adiantums, for the gold-dusted A. Williamsii, which so much resembles it in make, survives where Capillus veneris perishes, as also do A. chiliense, assimile, formosum, &c., the moral of which introduction is that if we want to find this Fern we must search our warmer coasts, where the Gulf stream baffles Jack Frost persistently, and if when we have it, we want to retain it, we must keep it warm in the winter. It is entirely distinct from any other of our native Ferns, the fronds being cut up into distinctly stalked fan-shaped divisions with slightly cut edges, and the spores wrapped up in short marginal lines in the rolled back edges of the pinnules. Its habitat is the cliffs and rocks of the sea shore, which gives the clue to the soil it needs for its thin creeping rhizome to penetrate and permit it to establish itself properly, *i.e.*, an open rubbly compost of vegetable mould and loam. Despite its comparative rarity it has not been chary in giving us improved editions of itself even *editions de luxe*, since Cornubiense, the plumose form, has dared to make a bold and fairly successful bid as a rival to that Queen of Adiantums, A. Farleyense; so far,

A Variety of our Hardy Maiden-hair Fern (Adiantum capillus veneris imbricatum).

however, it has failed to yield a crested form, unless that mysterious Fern A. Luddemannianum belong to the species.

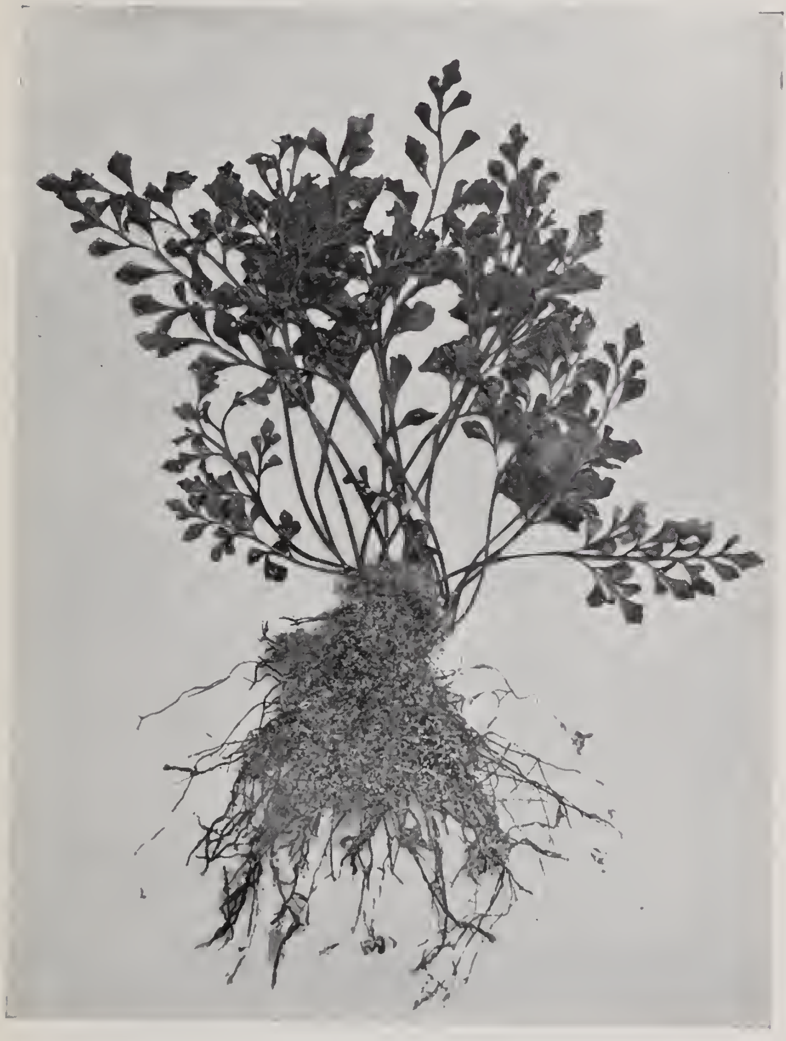
Name	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
Admirabile	—	E. J. Lowe (r)	Very large form.
Cornubiense	Hayle	Trevethick (1868)	Plumose *à la* Farleyense. A splendid form.
Daphnites	—	E. J. Lowe (r)	Erect fronds, crowded large pinnæ, very distinct, sometimes proliferous on edges.
Footii	County Clare	Foot	Very large pinnules.
Grande	—	—	,, ,,
Imbricatum	—	E. J. Lowe (r)	A dwarf imbricate dense form, something like Cornubiense, proliferous on sites of sori.
Magnificum	County Clare	—	A foliose variety.

ALLOSORUS CRISPUS (THE PARSLEY FERN).

ALTHOUGH this Fern has only afforded one variety, a very nicely crested one, and that is, unfortunately, lost in cultivation, it is too pretty to ignore. In hilly districts we find it sometimes very abundant, especially on the slopes of rocky *debris*, weathered down from higher levels, and in the vicinity of such stations it fills the crevices of stony dykes with its handsome tufts of frondage. It is deciduous, and has its spores on somewhat contracted fronds, which, however, are thrice divided, on same plan as the leafier barren ones. Its popular name indicates its somewhat Parsley-like appearance, the barren fronds being crispy. It is easy to establish in a garden (it objects to close culture, as a child of the hills should do) provided we remember the nature of its habitat and imitate this as far as possible. Our successful plan is to excavate a hole in a bed facing north, and make a station of peat and loam, in which we plant the clump. We then scatter a spadeful of stones and gravel on the top of it, burying the crown but not the fronds, and finally take a large piece of rock or brick burr and dump this on the south side, all but on the crown of the Fern. We then give it a thorough drenching and leave it alone. The Fern so treated persuades itself that this is another rock avalanche from above, to which it is accustomed, and very speedily we shall see it pushing its fresh fronds through the gravel and making itself quite at home, until in a week or two, in the growing season, it completes a fresh and permanent clump. Once so established it is good for all time, even in a London garden.

THE ASPLENIUMS (SPLEENWORTS).

OUR British Spleenworts embrace no less than ten species, including Ceterach officinarum, which undoubtedly belongs to the family; hence no other genus is so well represented. For the purposes of this list, however, the majority of these species are valueless, the varieties being unimportant. We may, therefore, dismiss at once Asplenium ruta-muraria (page 39), A. germanicum, A. fontanum, A. viride, A. septentrionale, and A. lanceolatum with the remark that as denizens of old walls in exposed positions, or, in the case of A. viride, of sheltered nooks, in rocks (limestone for preference), by stream sides, or on the mountain tops, their culture is not of the easiest. In pans, however, practically filled with drainage material mixed with leaf-mould and limestone rubble, and placed near the glass, we have seen good specimens established, but we ourselves have succeeded best by excavating a hole about a foot deep and a yard in diameter in a Fern-bed facing the north, making a station of limy, rubbly material on the bottom of it, facing it all round with rough pieces of limestone, in the chinks of which the plants were inserted. A large bell-glass supported by stones covered the whole in such a way that air had free access beneath it. This fairly representing natural conditions, the bell-glass protecting the plants from soot and dust of a London garden, the Spleenworts throve and flourished. A shallow, glazed frame on the same principle would serve for a larger number, or such stations could be multiplied. The greatest danger with the family seems to be the deposition of moisture on the fronds for any length of time, as they are then very apt to rot and go wrong. A. ruta-muraria figures in Mr. Lowe's book for sixteen varieties, but none of them rank as choice things. A. viride has yielded twelve, to which may be added a charming dwarf imbricatum found by the Rev. Mr. Maclean, Aberfeldy, and sent to the writer years ago, but long since defunct. The varieties, however, like the normal form, are extremely difficult to establish, and we are not sufficiently sure of the existence of any to be able to add them to our list. A. septentrionale and A. germanicum have done nothing. A. fontanum is in itself a little beauty; the only variety worth notice is refractum, a curiously lengthened edition with bulbils on base of fronds. A. lanceolatum has yielded the curious A. l. microdon, a barren form, considered by some to be a hybrid with A. marinum, large, confluent pinnæ. A beautifully crested form was found abroad by Mr. Boyd, but



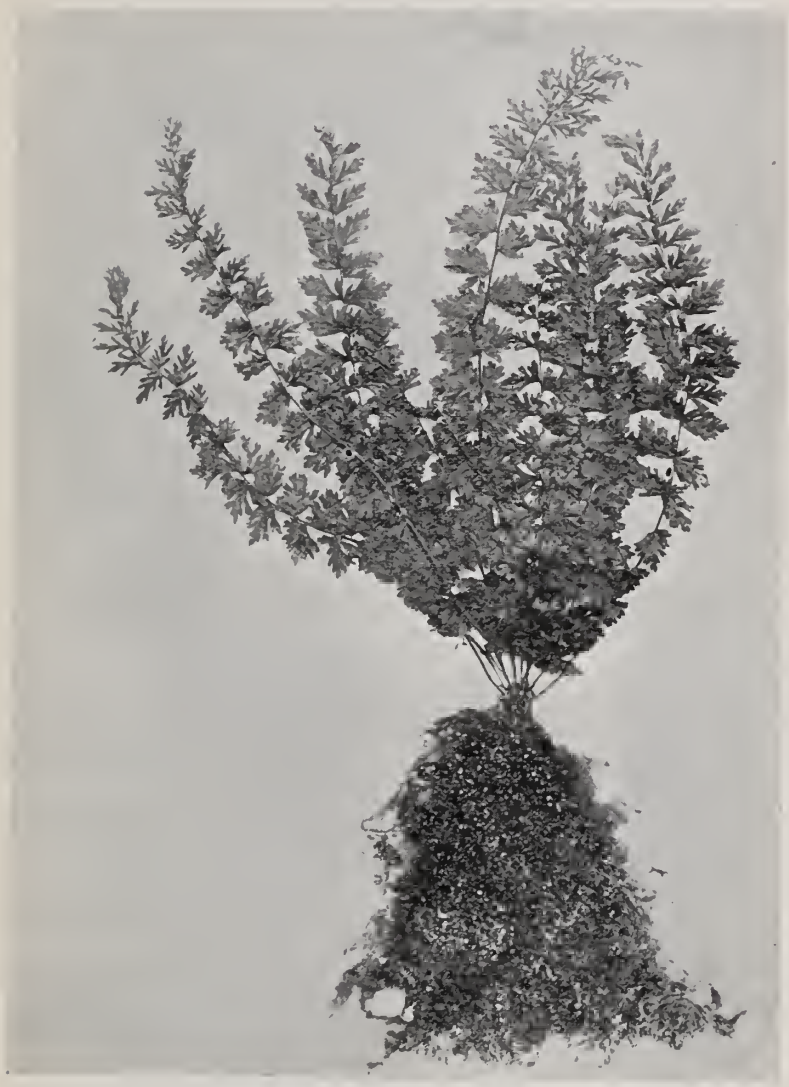
ASPLENIUM RUTA MURARIA.

this, we fear, no longer exists. Other forms are recorded, but none of value. All the species are thorough evergreens. To come now to the species which afford us really good material, we may start with

THE MAIDEN-HAIR SPLEENWORT (A. TRICHOMANES).

This pretty species is very widely distributed, and is found on old walls, on stony dykes and hedgebanks, and on rocks. Its fronds are simply pinnate, the black midrib sometimes over a foot in length, but usually about half that size, bearing two fairly even rows of oval-stalked divisions, on the backs of which the linear fructification of the species appears. Culture as previously indicated. The chief superficial difference between this and A. viride is that the latter has a light green midrib, to which, moreover, the pinnæ are firmly attached in life and death, while those of A. trichomanes fall off when decay sets in. A. trichomanes has been fairly generous in varieties, especially since the whole family is chary of change. The following are the best:

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
bipinnatum	Wales	Roberts	A remarkable form, in which the pinnæ in robust plants are pinnate, like small fronds.
confluens Stabler	Levens	Stabler (1870)	A presumed hybrid between A. trichomanes and A. marinum, doubted, however, by many. Fronds large and leathery, and confluent at tips.
,,	Whitby	W. Willson	Upper half of frond confluent.
,,	Ireland	P. N. Fraser (1875)	
,,	,,	W. Forster	Identical with Stabler's find.
,,	,,	J. J. Smithies	
cristatum	Various	Various	Head divided into more or less ramose tassels.
corymbiferum	Cusnip Gill	R. C. Brown	Bunch crested.
	Crossthwaite	Barnes	
Harovii	—	Wollaston	Small, serrate pinnæ, fronds narrow.
		Colonel Jones	
		E. J. Lowe	
imbricatum	Knaresboro'	Clapham (1863)	Pinnæ very large and overlapping, confluent at frond tips; a little like confluens.
incisum Clapham	Yorkshire	Clapham (1859)	The finest plumose form; pinnæ very large, deeply cut, and overlapping. A gem.
,,	Somerset	Latham	Similar plumose forms, but not so foliose. All are barren and true plumosums, except one found in Glamorgan.
,,	Various	Various	
laciniatum	County Clare	Stansfield (1863)	A laciniate incisum.
Moulei	Devon	Moule	Resembles Harovii, but more deeply incised.
multifidum	Various	Various	Ranks with cristatum.
ramo cristatum	Cornwall	Sargeant (1861)	Very broad-headed cristatum.
,,	Cardigan	Patey (1873)	
ramosum	Various	Various	Fronds repeatedly branched.
troggyense	Wentwood	Lowe (1882)	A fine, deeply-cut form.



Asplenium trichomanes var. incisum.

THE BLACK MAIDEN-HAIR SPLEENWORT (A. ADIANTUM NIGRUM).

This species is quite distinct from any other; long, black stems and twice-divided triangular, somewhat leathery fronds; habitats, old walls and dykes, and also hedge-banks, assuming its largest size in shady lanes; soil more leafy than with the other species.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
acutum	Various	Various	Normally A. a. nigrum varies much in relative bluntness or acuteness of terminals; the warmer the climate, apparently the more acute and slender the divisions. Good forms of acutum are very handsome.
grandiceps	Ilfracombe	R. A. Thompson (1865)	Two very similar forms with heavy, spreading, fan-like crests on frond; terminal pinnæ few and flabellate. The Devonshire form has the pinnæ more in evidence.
,,	Waterford	Rev. T. Smith (1865)	
microdon	Ashburton	Bickford Richards	Large, confluent pinnæ; a presumed hybrid between this species and A. marinum, but also open to doubt, Ashburton lying inland far from A. marinum influence.

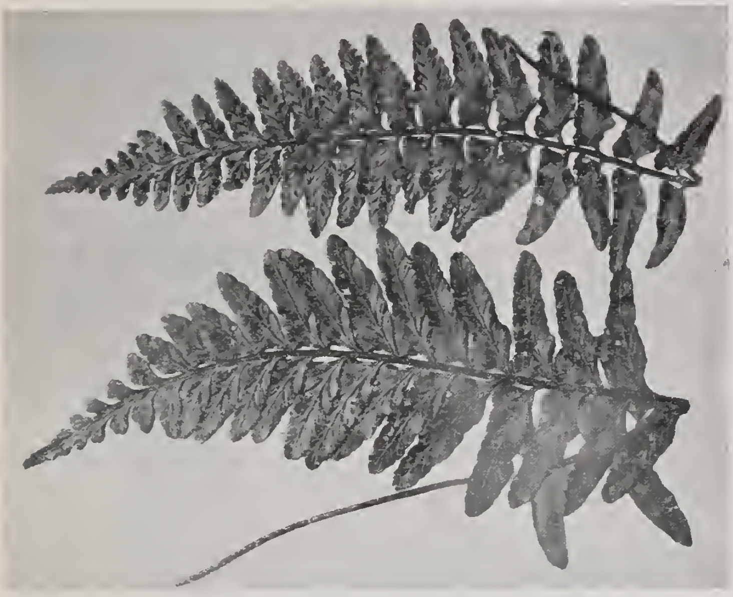
THE SEA SPLEENWORT (ASPLENIUM MARINUM).

A tenant of sea caves and rocks adjacent, thriving in spots which must often be drenched with brine. The once-divided fronds are tough, leathery, and evergreen (page 43), but the Fern is nevertheless tender, and will stand but little frost. On the other hand, it thrives under warm culture, and we have seen it in a vinery at Kew with grand 2 feet fronds, forming a huge plant 1 yard through and 2 feet high. Hence, despite its native origin, it will well repay exotic treatment. There are several varieties, but for ornamental purposes we can only recommend:—

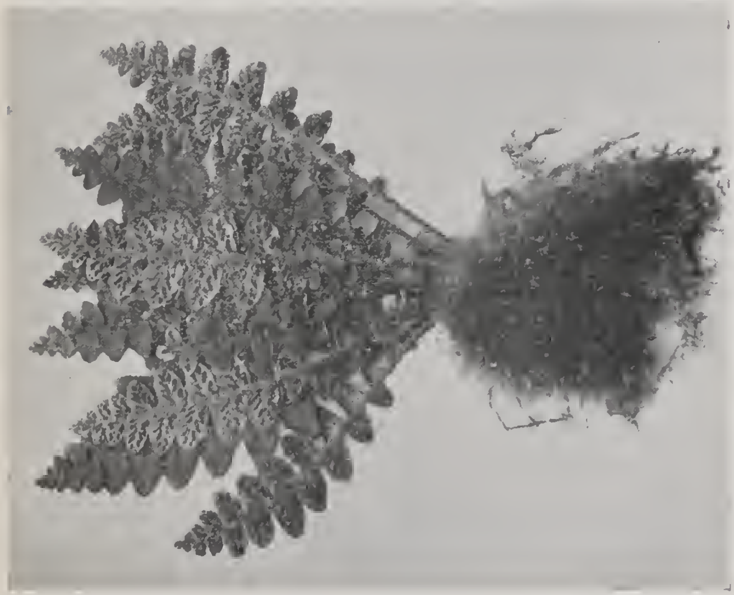
Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
A. m. imbricatum	Lowe	—	A distinct, dense form.
A. m. plumosum	—	—	A thoroughbred plumose, twice-divided, and robust form, barren and rare.
A. m. ramo-trapeziforme	Scarborough	Clapham	A ramo-cristate form.

THE SCALY SPLEENWORT (CETERACH OFFICINARUM ASP. CETERACH).

A lover of the sunny side of ancient walls, where it revels on old mortar pure and simple. It is a pretty little Fern, with dark olive-green, leathery, once-divided fronds of a long, oval



Asplenium marinum.



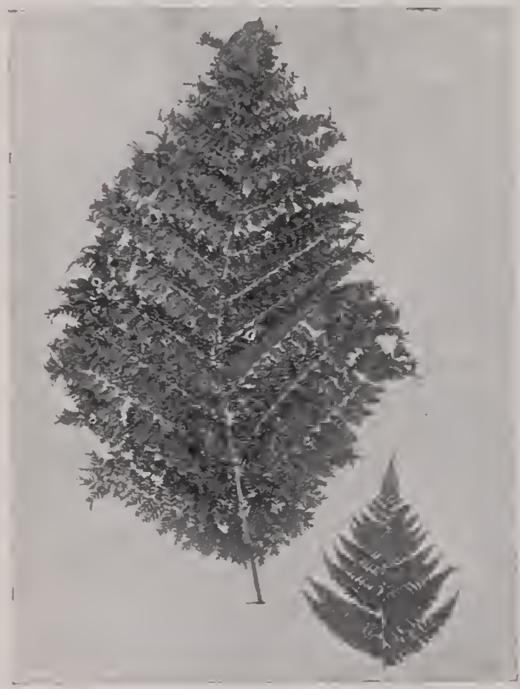
Asplenium Ceterach (Ceterach officinarum).

shape, with broad, blunt pinnæ, sometimes crenate, and thickly clothed on the back with dense, brown scales (page 43). It withstands drought to almost any extent, surviving actual shrivelling for months, and yet reviving, when subsequently soaked, like a true tropical species. A number of forms have been found, mainly in Ireland. The best are:

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
cristatum	County Clare	O'Kelly	Neatly fan-tasselled.
grandiceps	,,	,,	More heavily tasselled.
multifido-cristatum	,,	,,	Multifidly crested.
ramoso-cristatum	,,	A. Wise	Branched and tasselled.

ATHYRIUM FILIX-FOEMINA (THE LADY FERN).

THIS Fern, classed by botanists as an Asplenium, has no affinity with that family either in appearance, habitats, or relative stability of form, being one of the most variable Ferns in the world, while the Asplenia generally are peculiarly constant. In its varietal forms it varies in size from 4 feet in height to 2 inches or 3 inches, and in its wild state varies so much in detail that it is often difficult to find two plants exactly alike in cutting and general make. It affects moist habitats and even boggy ones, but, generally speaking, is one of the least dainty in its requirements, so long as it is not subjected to actual

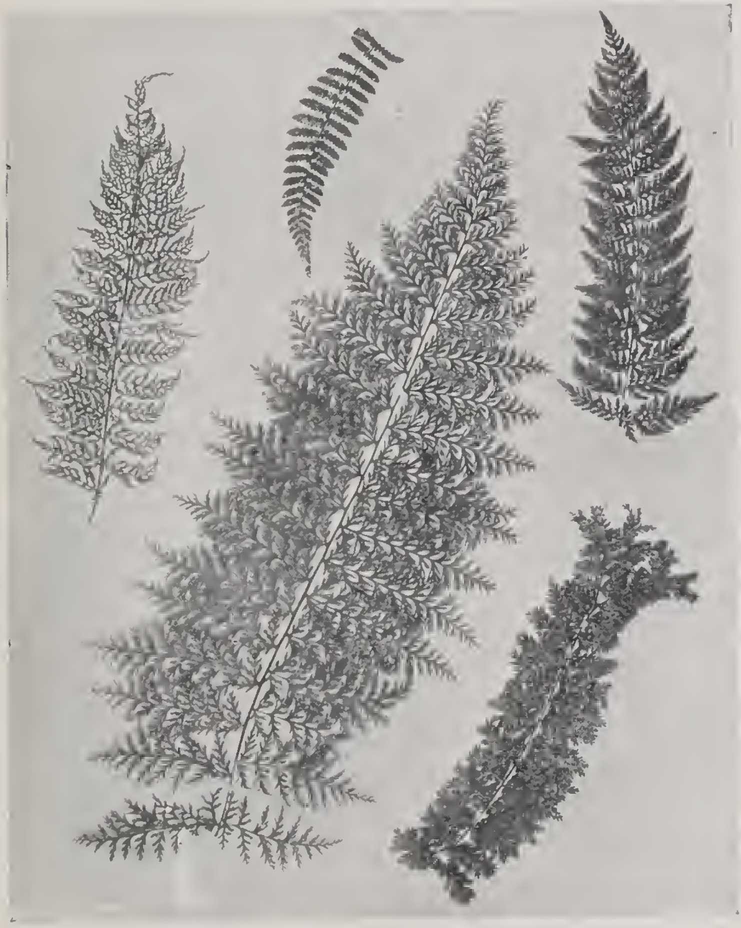


A. F. F. PLUMOSUM DRUERY (YOUNG FROND).

drought at the root. Hence any soil suits it, though naturally an open, leafy compost is the best. It assumes its greatest size and utmost delicacy in sheltered, shady glens near running water. In moist climates it does well in the open with shelter from wind and sun, but in dry ones is the better for glass protection with plenty of air, especially if large varietal specimens are in question. The dwarfs are less exacting, being naturally less liable to damage by wind. Normally the fronds are thin in texture, range from 2 feet to 4 feet in length, with a bare stem for some inches, the pinnæ 1 inch or 2 inches in length at the bottom, widening gradually to 4 inches or 5 inches in the centre, and tapering off to the pointed frond-tip, *i.e.*, the fronds are broadly lanceolate. They are divided twice or thrice (bipinnate or tripinnate) according to size. Abnormally this Fern seems capable of anything. The Lady Fern is quite deciduous, the fronds dying down in the autumn quite independently of frost; sori horseshoe-shaped, with a ragged indusium or cover; spores smoothly oval or kidney-shaped.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
abasilobum	—	—	*See* mediodeficiens.
acrocladon	Castle Howard	Monkman (1860)	Ramose from base, and throughout forming a mossy ball.
a. densum	—	Stansfield (r.) (1878)	Similar, but denser growth.
apuæforme	Dent	J. M. Barnes (1870)	Fronds fish-shaped, crested.
a. Hodgson	Torver	Mrs. Hodgson (1867)	Similar to last.
Axminsterense	—	—	*See* plumosum Axminster.
Blakæ	—	Parsons (r.)	Plumose, beautifully crested; nearest approach to superbum; probably same origin.
canaliculatum	—	Stansfield (r.) (1882)	Fine grandiceps, with channelled rachis.
capitatum	—	—	Short fronds, thick crest. A crested Frizellæ.
caput Medusæ	—	Mapplebeck (r.)	Densely comminuted head, with twisted segments.
cathedrale	Lichfield Cathedral	More than 200 years ago	Dwarf, prettily crested.
Clarissima Jones	North Devon	R. Moule (1868)	Large, lax, attenuated pinnæ and pinnules, very beautiful, apospory first discovered on this, sori producing prothalli instead of spores.
C. Bolton	Lancs.	T. Bolton and friend (1893)	Smaller than last, and finer cut. Is aposporous at all points as well as sorally. Original a little inconstant, progeny very so; mostly worthless.
congestum Paul	Cornwall	Paul (1864)	Dense and dwarf, very pretty, and quite distinct.
,, ,,	Todmorden	T. Stansfield (later)	,, ,,
c. Phillips	Antrim	Phillips (1888)	,, ,,
c. Whitwell	Kentmere	Whitwell (1897)	,, ,,
c. Simpson	—	Simpson (1869)	Dense, dwarf, and crispy.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date*	*Description.*
c. cristatum	—	E. J. Lowe (r.	Dwarf, densely crested.
c. c. Fitt	—	Fitt	Dwarf, densely crested, resembles Findlayanum.
congesto-cristatum (Findlayanum	—	Stansfield (r.) (1870)	Dwarf, densely crested, distinct.
congestum excurrens	—	Stansfield (r.)	Dwarf, dense, truncate, and horned at all tips.
c. grandiceps	—	Stansfield (r.) (1885)	Raised from Fitt's cristatum; heavier crests.
c. minus	Ireland	Riley	Misnamed Edwardsii; a dense, dwarf, crispy gem.
c. m. cristatum	—	Cropper (r.) (1895)	The same, crested.
conioides	Doncaster	Appleby	Pinnæ short and Hemlock-like; a beauty.
,,	Antrim	Praeger	
c. cristatum	—	Stansfield (r.)	Same character, crested.
coronatum	—	—	Frond heavy, crested; pinnæ plain.
corymbiferum James	Guernsey	James	Grand form, splendid bunch crests at all terminals.
crispatum Paul (Grantæ)	Cornwall	Paul (1865)	Fine, dense, congested, crispate.
crispum	Antrim, Braemar, and Todmorden	—	Dwarf, ramose, and crested; rambling habit.
cristatum	—	—	Numerous forms, mainly specified elsewhere under various names. The type is simply tasselled at frond and pinnæ tips
c. Smithies	Wastdale	Smithies	Pendulous, polydactylous form.
cristulatum	—	Stansfield (r.)	Branchy crests, cristulate pinnæ *à la* gemmatum.
curtum	—	—	Pinnæ short, and egg-shaped in outline.
c. cristatum	—	Stansfield (r.)	Pinnæ short, and egg-shaped in outline; neat rounded crests.
c. grandiceps	—	—	Pinnæ short, and egg-shaped in outline; heavy crests.
depauperatum	Ben Bulben.	Gunning	Misnamed really; small, pretty, and slenderly finger-crested.
Elworthii	Nettlecombe	C. Elworthy	A flat-fronded per-cristatum; very fine.
excurrens	Tunbridge Wells	(1853)	All tips truncate and thorned; neat.
Fieldiæ	—	—	Narrow, truncate fronds, with cruciate bunch pinnæ.
fimbriato-cristatum	—	Garnett (r.) (1899)	A lax and charming cristatum; very distinct.
flabelli-pinnula	Westmoreland	Mrs. Wilson	A tiny gem, with stellate spiky pinnæ.
flexuosum	Lancs. and elsewhere	(1858, &c.).	A curio; fronds twisted and pinnæ revolute.
fœcundulo-sissimum	—	C. T. Druery (r.)	Dwarf, narrow fronds, dense, capitate, proliferous crests.
formoso cristatum Elworthy	—	Elworthy (r.)	Very fine crested form raised from gemmatum.
Forsteri	—	—	*See* ramosum Forster.
Frizellæ	Wicklow	Mrs. Frizell (1857)	Pinnæ regularly reduced to round knobs, progeny capricious.
,,	Donegal	H. C. Hart	,, ,,
F. capitatum	—	Various (r.)	Numerous forms raised, probably by unintentional crossing; fronds of the narrow type, with more or less dense or spreading terminal crests. Most are apt to revert somewhat erratically to normal or presumed parents.
F. cristatum.	—	,,	
F. multifidum	—	,,	
F. ramosum. (Applebyanum)	—	—	



Improved Form, raised by Mr. Parsons from Axminster plumosum.

Normal Form of Species.

Plumose Wild Sport Axminster plumosum.

A. f. f. pl. Druery, raised from Superbum.

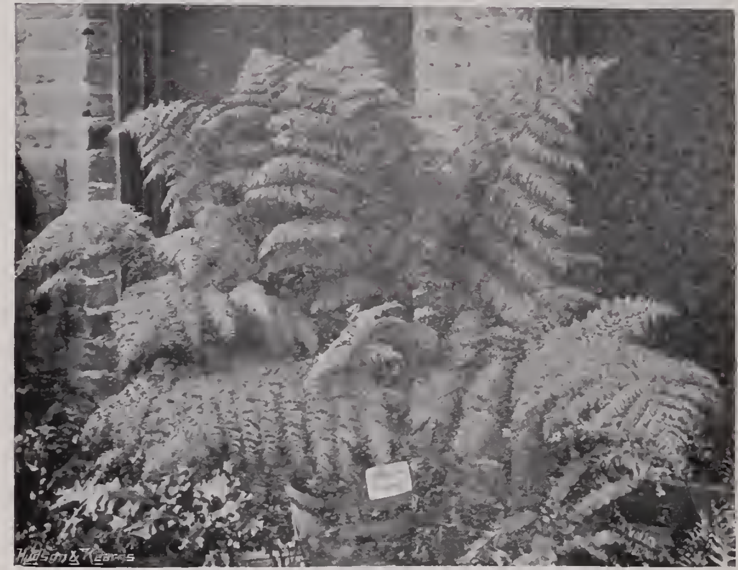
A. f. f. Superbum, raised from Parson's Form.

N.B.—Pinnæ only throughout.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
F. ramosissimum	—	Mapplebeck (r.) (1873)	Dwarf, fronds ramose from base; very pretty.
F. cristatum congestum	—	—	Dwarf crested form; very good.
gemmatum	—	J. M. Barnes (r.)	Narrow; all tips heavily bunch crested.
Girdlestoneii	Ross	Canon Girdlestone (1866)	Evenly depauperate in centre of frond and pinnæ, centre pinnules very slender and long; beautiful, but "miffy."
glomeratum	—	Ivery (r.) (1864)	Heavy, capitate head and side crests, pinnules fanned at tips.
grammicon	—	E. J. Lowe.	Dwarf, narrow fronds *à la* Fieldiæ; doubtfully distinct from that.
grandiceps	Nettlecombe	Elworthy	Heavy terminal crests.
,,	Wiveliscombe	Morse	,, ,,
,,	—	Tyldesley	,, ,,
,,	—	Whitwell	,, ,,
Grantæ	—	—	*See* congestum Paul.
Howardæ	Levens	Craig (r.)	Fine laciniate, well crested, depauperate centre, but good.
Huckii	Wet Sleddale	Huck (1874)	Beautiful long, crispy, crested pinnules.
Kalothrix	—	Howlett & Sim (r.) (1870)	Unique, divisions extremely slender, and lucent like floss-silk; reverts slightly to plumose form.
K. plumosum	—	Stansfield (r.)	A Kalothrix reversion, resembles A. f. f. p. Horsfall, the probable grandparent.
K. foliosum	—	Stansfield	Divisions wider than Kalothrix, but lucent reverts to same extent, but to normal.
Kilrushiense	Kilrush (Co. Clare)	C. T. Druery (1892)	Long, many-stranded tassels at all tips; almost a grandiceps, very distinct.
laciniatum elegans	—	Stansfield (r.)	Crosses between Craigii and Horsfall plumosum; elegans has cruciate pinnules, no crests; ramulosum is a multifid Horsfall.
l. ramulosum	—	Stansfield (r.)	
laciniatum	—	Stansfield and Smithers	Extremely fine divisions.
laxo-cristatum	County Down	Phillips	Long, lax pinnules, small crested.
lunulatum (Woll)	—	—	Synonym of Frizellæ.
magnicapitatum	—	Stansfield (r.) (1878)	Heavy-headed acrocladon, *flat* fronds.
mediodeficiens (abasilobum)	Wigton	C. T. Druery (1884)	Basal divisions of pinnæ and pinnules absent; frond and pinnæ consequently open in centre; the two finds are quite distinct.
,,	Strathblane	C. T. Druery	
m. caudiculatum	Ireland	Phillips	Same character, but all terminals evenly caudate and serrate, with translucent teeth; very pretty.
multiceps	Truro	—	Multifid crests.
multifidum	—	—	Applicable to forms bearing flat, spreading tassels, not re-dividing.
m. tenue	Lancs.	Mrs. Wilson (1869)	A small, slender, crested form.
multifurcatum	Westmoreland	Mapplebeck (1871)	Wide, ramose terminal crests, with acute divisions.

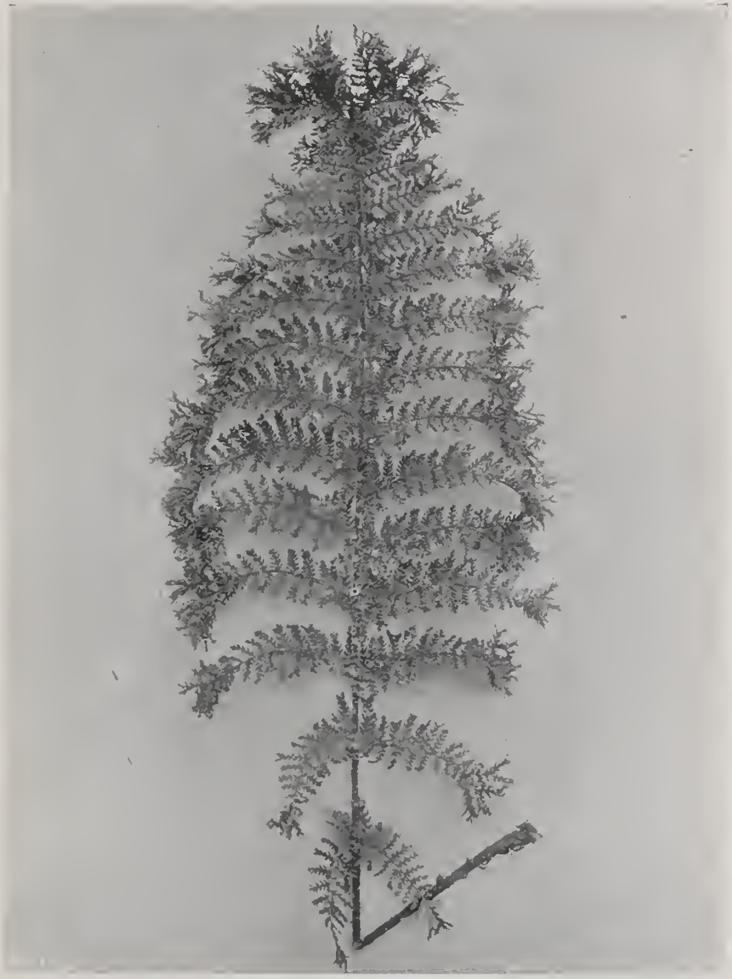
Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
nodosum	—	—	*See* Frizellæ.
nudicaule cristatum	—	Mapplebeck (r.)	Long, bare stalks, with capitate crests; small habit.
orbiculatum	—	Mapplebeck (r.)	Similar, on a larger scale.
percristatum Cousens	Snaresbrook	J. S. Cousens (r.)	A grand, robust, true percristate Fern; pinnules long and distinctly tasselled.
plumosum Axminster	Axminster	J. Trott (1863)	Beautifully plumose; progenitor of superbum strain, dorsally bulbiferous.
p. Barnes	Westmoreland	Barnes (1863)	A true plumosum, but less foliose than some.
p. divaricatum	Lancs.	W. Morris (1872)	One of the best, and perhaps the best as a find.
p. Drueryii	Forest Gate	C. T. Druery (r.) (1888)	Incomparably the finest plumosum; very robust, quinquepinnate; raised from superbum.
p. elegans Parsons	—	Parsons (r.)	Finer cut Axminster; parent of superbum.
p. Hodgsoniæ	Ulverston	Hodgson (1870)	A delicate true plumosum.
p. Horsfall	Skipworth	Horsfall (1857)	Grand plumose form; very distinct.
p. Jones	—	—	Large and elegant.
p. Pounden	Antrim	Pounden	A slender, erect, dissected form; very distinct.
p. Stansfield	—	Stansfield (r.)	*See* Kalothrix plumosum.
p. superbum	—	C. T. Druery (r.) (1886)	Finely flat-crested plumose raised from plumosum elegans and parent of A. f. f. p. Drueryii, and the following.
p. s. crispatum	—	C. T. Druery (r.) (1886)	Uncrested, lax, and crispate.
p. s. dissectum	—	,,	An improved p. elegans, uncrested.
p. s. foliosum	—	,,	Uncrested, dense fronded.
p. s. grandiceps	—	,,	Very heavy crests.
p. s. Kalon	—	,,	Lax, flat-crested, very handsome.
p. s. percristatum	—	,,	The finest percristate form of all, plumose, and with pinnulets crested.
plumosum Wills	Dorset	Wills (1869)	A very robust and finely cut form.
pulcherrimum	—	M. A. Walker (r.) (1868)	Dwarf, pinnules long and serrate; very pretty.
p. Jackson	—	Jackson	A more foliose form.
p. cristatum	—	—	A crested form.
Pullerii	Isle of Skye	Puller (1864)	A pinnate form, with short, rounded pinnules *à la* Frizellæ, but closer.
ramo-cristatum	—	—	Branched and crested.
ramosum Forster	Woodhead	Forster (1879)	Ramose.
ramulosissimum	Montgomery	Middleton (1872)	Fronds ramify from base, and all tips crested, very pretty, dwarf.
r. Mapplebeck	—	Mapplebeck (r.) (1870)	Ditto, but larger.
r. lineare	—	Edwards (1894)	Much branched, very slender.
rectangulare	Westmoreland	Mrs. Wilson (1870)	Divisions so slender that sori show on edges; pretty and curious.
recurvum multifidum	—	—	Pinnules recurved, fronds crested.
reflexum	Westmoreland	Clowes (1858) and others	A curious flexuose form.
regale	Near Appleby	Barnes (1867)	Splendidly sub-plumose and percristate.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
revolvens	Strathblane	C. T. Druery (1891)	Fronds and pinnæ rolled up convexly and symmetrically, terminals ringlet twisted.
rotundatum	—	—	A pinnate form, with short, rounded pinnules *à la* Frizellæ, but closer.
setigerum	Lancs.	Garnett (1878)	Normal outline beautifully divided, points bristly; yields crested forms from spores, very diverse, but with tendency to revert.
s. coronatum	—	Birkenhead and others	The names describe, but there are innumerable seedlings, one type merging into the other.
s. corymbiferum	—	—	" "
s. cristatum	—	—	" "
s. grandiceps	—	—	" "
s. percristatum	—	—	" "



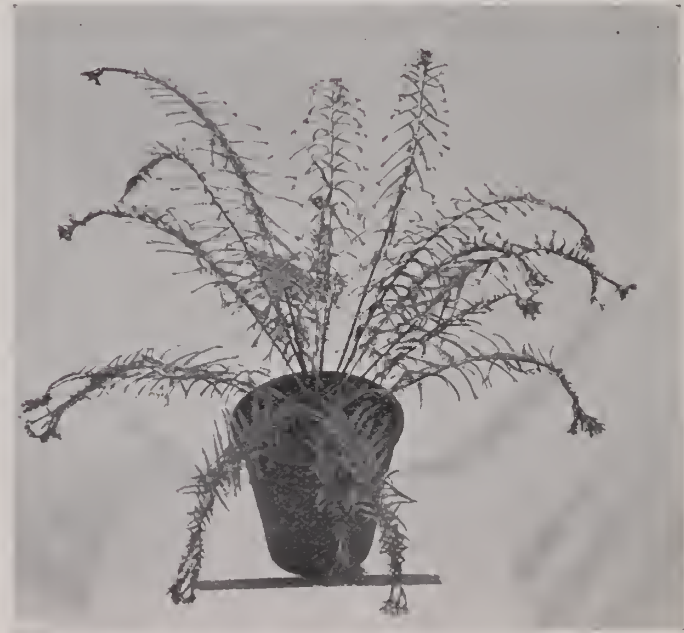
A. f. f. plumosum Druery, accepted by H.M. Queen Victoria.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
s. Victoriæ	—	Birkenhead	A cross with Victoria, percruciate and crested like that, but bristly throughout.
Simpsonii	—	—	*See* congestum Simpson.
splendens	—	Craig (r.) (1864)	Finely crested; lovely thing.
stipatum	Cornwall	Paul (1864)	*See* congestum Paul.
superbum	—	—	*See* plumosum superbum.
thyssanotum	—	—	Pretty crested form.



A. F. F. TODEOIDES CRISTATUM (TROUGHTON).

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
Todeoides	—	Stansfield	Peculiarly neatly cut, but hardly Todea-like.
T. cristatum.	—	Troughton (r.) (1882)	A charming crested form of same.
unco-glomeratum	—	Stansfield (r.) (1878)	Raised from acrocladon, unique, resembles a spherical green coral, division endless, culminating in bulbils and prothalli (apospory).
uncum	Levens	Barnes (1860)	Fronds very narrow, pinnules hooked.
velutinum	—	Stansfield (1878)	A dense, dwarf acrocladon.
Vernonæ	—	Vernon	A gem, divisions crispy and wide.
V. corymbiferum	—	Stansfield (1877)	Well crested form of above.
V. cristatum	—	Jones (r.) (1873)	,, ,,
Victoriæ	Stirlingshire	Cosh (1861)	Unique percruciate form, long slender pinnæ in pairs at right angles, with slender tassels at all terminals. Original nearly 4 feet.
V. elegans	—	Lowe, McNab, and others	Sub-varieties, but none excel the original or differ markedly from it.
V. gracile	—		
V. magnificum	—	— —	
V. setigerum	—	— —	*See* setigerum Victoriæ.

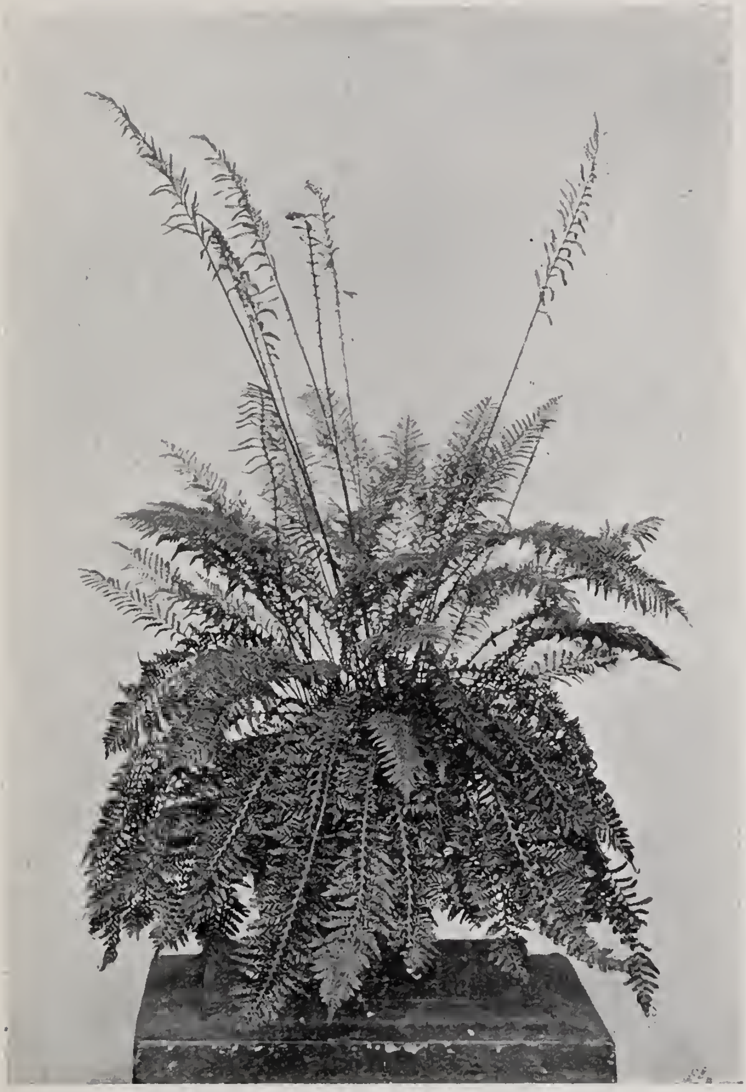


A. F. F. VICTORIÆ.

BLECHNUM SPICANT (THE HARD FERN).

WE carefully abstain from calling this species Lomaria, because its form of fructification—which determines the species—is that of Blechnum, differing from that of Lomaria in the fact that each line of spore heaps has a special independent membranous cover springing from well inside the edge of the pinnæ, while in Lomaria the pinnæ edge itself forms the cover by rolling backwards. As a very cursory examination determines this, and scientific botanists themselves have separated the two genera for the reason stated, it is a curious anomaly that the name Lomaria should be adopted. Blechnum spicant is a solitary species of the genus in Great Britain, and has earned the name of Hard Fern by the tough leathery texture of its intensely dark green fronds. These are normally once divided like two blunt and widely toothed combs set back to back; a further and unmistakable characteristic is that two kinds of fronds are produced, fertile and barren, the former being erect and longer than the other, and the pinnæ much narrower, only wide enough indeed to bear the twin lines of spore heaps with the midrib between and the indusia or covers. In favourable situations the plant assumes fairly large proportions, the barren fronds as much as 2 feet long, and the fertile ones little short of 3 feet high. It dislikes lime, and revels in a loose damp leafy or peaty soil, though thriving also in a smaller form in friable loam alone. Damp hedge banks, ditch and stream sides, and shady woody slopes are its pet abiding places; it also loves moorland, and is there found in quantity associated with Heather and Lastrea montana. It is perfectly evergreen, but under culture its dislike of lime must be remembered, and hard water sedulously avoided. The two types of fronds are maintained in all its varieties but anomalum, not rare in hilly districts, which apes its foreign relatives by bearing spores on uncontracted fronds, and thus lodges an additional protest against the Lomaria christening. It is not difficult to raise from spores, and the progeny come, as a rule, peculiarly true, hence most of the forms listed are wild finds. The species is very widely distributed over the British Isles, and attains a high elevation on the mountains. Its chief antipathies are drought, aerial or terrestrial, and hard water. Curiously enough, though exotic species are numerous, very few seemingly have sported, while our native species has been fairly prolific in very marked forms.

Name.	*Where Found or Raised*	*Finder or Raiser and Date.*	*Description.*
Aitkinianum	County Clare	A. Stansfield	A wide spreading ramose projectum.
anomalum	Various	Various	Fronds all fertile but little if at all contracted.
anomalum multifidum	Rydal	W. Crouch (1867)	The same crested.
bellum	Hutton Roof	J. J. Jones (1864)	Normal outline, neater cutting.
concinnum Druery	Simonsbath	C. T. Druery (1881)	Pinnæ like serrate scallop shells.
confluens	Gap of Dunloe	C. T. Druery (1892)	Frond tips confluent and crispate.
congestum	Wastdale	Crouch (1876)	Dense congested.
contractum	Various	Various	Bottom of frond merely evenly lobed for some inches.
crenato congestum	Patterdale	W. Forster	Pinnæ congested ovate and crenate.
crispum	Langdale	Barnes (1872)	Pinnæ broad and crispy.
,,	Blawith Moor	Mrs. Wilson (1869)	,, ,,
crispissimum	—	Hartley (r.)	A dwarf congested gem.
cristatum	Various	Various	Fronds multifidly crested. (Page 61.)
cristatum Huddart	Windermere	Huddart	Finely crested.
cristatum Barrandæ	—	Miss Barraud (1892)	Very neatly crested, pinnæ sub-crested.
cristato-gracile	Red Bank	Crouch (1865)	Narrow and crested.
cruciato-plumosum	—	Forster (r.)	Very fine and foliose, with cruciate divisions.
flabellatum	Helmsley	Monkman (1835)	A fan-shaped ramo-cristatum branching from base.
glomeratum	—	Maunder (r.) (1878)	A dwarf densely-crested mass.
imbricatum	Lake Bank	Mrs. Hodgson (1870)	Congested, imbricate. (Page 61.)
imbricato-erectum	Todmorden	Halstead	Congested and erect.
lineare	Witherslack	Barnes (1862)	Fronds narrow and almost strap-like, most distinct.
Maunderii	—	—	*See* glomeratum.
multifidum	Various	Various	*See* cristatum and polydactylum.
multifurcatum (trinervio-coronans)	Langdale	Barnes	Pinnæ slender, fronds end in radiate spiky crests; rarely the two basal lobes are lengthened and crested, hence the second name.
paradoxum	Bainsdale	Whitwell (1877)	No beauty but unique, having a third row of pinnæ like a perch's back fin.
parviceps	Ronstead Gates	Mrs. Hodgson (1868)	Small stellate crests.
plumosum	—	Airey (r.)	A *thrice* divided grand form. (Page 55.)
polydactylum	Various	Various	*See* cristatum and multifidum.
ramo-cristatum	Kidwelly	Maunder (1876)	Dwarf corymbiferous crests.
,, Forster	Scotland	Forster	Fine foliose ramo-cristate form.
ramo-cristatum Kinahan	Ireland	Kinahan	Ramo-cristate and twisted, pinnæ subcristate. (Page 61.)
ramo-cristatum Sinclair	Strathblane	Sinclair	A fine flat ramo-cristatum.
ramo-multifidum	Crook	Mrs. Hartley (1864)	Ramose and crested.
,,	,,	Robinson (1879)	,, ,,
semilacerum Airey	Windermere	Airey	Nearly bipinnate.
serratum	North Wales	J. Cliffe (1865)	Pinnæ serrate.
,, Airey No. 1.	—	Airey	Pinnæ deeply cut, parent of plumosum.
serratum Airey No. 2	—	,, (r.)	*See* plumosum.
strictum	Various	Various	Lower half of frond reduced to round lobes, usually serrate, and pinnæ rather narrow.



Blechnum spicant var. plumosum Airey.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
stricto-concinnum	Crook	Barnes (1865)	Narrowed like concinnum, but less serrated.
subserratum	Todmorden	A. Stanfield (1860)	Pinnæ curved regularly upwards, and deeply cut on lower halves.
,,	New Forest	F. H. Stansfield	
trinervium	Common in some parts	W. H. Phillips and others	Basal pinnæ lengthened and pinnate
,, Hodgson	Kirkley Moor	Mrs. Hodgson	Basal lobes developed into fronds forming a trident.
trinervio-coronans	—	—	*See* multifurcatum.

BOTRYCHIUM LUNARIA (THE MOONWORT).

THIS ranks, with the Adder's-tongue, amongst the lowly forms of our British Ferns, having, like that, only one frond, with a fertile spike in the centre. The frond, however, is once divided, and the fertile spike is also divided, so that it is easily distinguished. It grows in dry mountain pastures, but is very inconspicuous and difficult to cultivate. It has also furnished no notable varieties, and hence is mentioned here merely by way of completing the list of native species, since, though pretty in its way, it cannot be considered of any decorative value, nor does it lend itself to culture.

CYSTOPTERIS (THE BLADDER FERNS).

THE Bladder Ferns, though pretty enough in their native habitats, viz., chinks in rocks and stone dykes, besides a lack of definite variety, have a terrible knack of becoming brown and almost black under cultivation; their fragility, too, is against them as decorative Ferns, and hence we mainly allude to them as evidence that they have not been forgotten. Three species are imputed to Great Britain—C. fragilis. C. alpina, and C. montana, the last of which resembles P. dryopteris in form of frond and cutting, and is decidedly the prettiest of all. We have had it growing rampantly in a slate trough, well drained and filled with rough peaty and loamy compost. The tribe obtains its botanical and popular name, which is an exact translation, from the fact that the indusia or spore covers are thin and globular, resembling tiny bladders. All have creeping roots, and form clumps which, subject to the disadvantage aforesaid of discoloration, are pretty enough in rocky chinks under glass or in the open. C. fragilis is the only one which has sported, the only two really marked forms are C. f. var. cristata, raised and found wild subsequently, in which the fronds vary from almost normal, through prettily crested types up to grandiceps, with quite small pinnæ, and C. f. var. Dickeana, a dense-fronded dwarf form, very pretty, which has been found in several places. C. f. crispa resembles this, but is crispier.

GYMNOGRAMMA LEPTOPHYLLA.

THIS is only a Britisher in a political sense, since it gets no nearer than Jersey, though largely distributed in other parts of the world. It belongs to the tribe of Gold and Silver Ferns, but is not ambitious in that line, though pretty. It is almost thrice divided, and has slender fronds 3 inches or 4 inches high. It enjoys the distinction of being one of the very few Ferns which are annuals, *i.e.*, not merely deciduous, but actually dying after shedding its spores; consequently, it can only be grown under a bell-glass, where its spores can germinate and so perpetuate it. It wants a moist soil and plenty of light, like all its relatives. No varieties.

THE LASTREAS (BUCKLER FERNS).

THE Lastreas (or Nephrodiums) derive their common name of Buckler Ferns from the shape of the indusium or spore heap cover, which has a fanciful resemblance to a buckler or shield, but is better described as kidney-shaped, which the word Nephrodium implies. The Shield Ferns (Polystichum), apart from their mitten-shaped pinnules, have perfectly round indusia, and hence are easily distinguished. The Lastreas, taken as a body, undoubtedly embrace our commonest and most prevalent species, abounding in profusion everywhere where Fern-life is at all favoured. The genus is represented in Great Britain by no less than nine species and sub-species, viz., Lastrea Filix-mas or the male Fern, with its sub-species L. pseudo-mas and L. propinqua, L. dilatata or the Broad Buckler Fern (with which we include L. spinulosa and L. uliginosa), L. œmula, the hay-scented Fern, L. oreopteris or montana, the mountain Buckler Fern, L. rigida, L. thelypteris, the marsh Buckler Fern, and L. cristata, a narrow fronded form probably of L. dilatata, and named cristata with no justification at all.* As regards culture the male Ferns will grow in any soil, L. dilatata and its kin have a predilection for peaty leafy moist habitats, L. œmula especially. The mountain Buckler Fern abhors lime and revels in yellow loamy well-drained soil, with a dash of leaf-mould, needs plenty of moisture. L. rigida is a limestone species, and is only found on that formation. L. thelypteris is a true bog plant, growing in mud and boggy ooze. The last-named species has yielded no varieties, L. rigida none worth having save a pretty cristate form only found to die under cultivation. L. cristata, besides belying its specific name, has refrained from any attempt at a justificatory sport; the remainder of the tribe, however, have done good service, and we will now deal with them seriatim.

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* Note by Dr. Stansfield.—L. dilatata, spinulosa, uliginosa, and cristata form a chain of sub-species in the order named, the extreme forms are as distinct as any two species in the genus, but the intermediate forms merge into each other. L. cristata is a real bog Fern, dilatata does not grow in bogs though it is found on islands in bogs.

L. FILIX-MAS (THE MALE FERN).

THIS species is so distinctly sub-divided that we must treat it as three, adopting Mr. G. B. Wollaston's classification: "L. f.-mas with convex fronds and pinnæ, pale green thin textured fronds with serrate pinnules, small indusia and deciduous habit, L. pseudo-mas with thick leathery flat golden green fronds, almost smooth edged pinnules and large lead-coloured indusia; evergreen habit. L. propinqua, concave fronds and pinnæ, dull green soft textured fronds, serrate pinnules, large indusia, and deciduous habit." L. pseudo-mas is also distinguished by its profusion of light brown scales. L. prop.-mas is only locally plentiful mainly in mountain districts, the other two are generally distributed and are often associated together, L. f.-mas being in the majority. In cultivation the tough evergreen nature of L. p.-mas entitles it to the preference where space is restricted. Under glass it retains its beauty well into the second season and until the fresh fronds are fairly developed. The fronds of all are normally twice divided (bipinnate), the pinnæ commencing some distance up the stalk and forming broadish lanceolate fronds 2 feet to 3 feet in height, ranged shuttlecock fashion round the caudex.

L. FILIX-MAS.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
Acrocladon	—	Clapham (r.)	Prettily crested, but not branched like A. f. f. acrocladon.
Barnesii	Heversham	J. M. Barnes	Narrow form; pinnæ ovate.
Bollandæ	Kent	Mrs. Bolland (1857)	The only plumose form, somewhat depauperate.
confluens	—	W. H. Phillips	A fine confluent form.
crispata	Coniston and elsewhere	J. K. Hodgson and others (1864)	A compact, crispy form.
crispatissima (fluctuosa)	—	—	Similar form.
cristata	Rydal	Crouch (1864)	Well crested
c. Ellacombi	Pembroke	Ellacombe (1856)	Very fine cristate form.
c. Martindale	—	W. Martindale (1872)	" " "
c. Routledge	Old Hutton	Routledge (1872)	" " "
decompositum	South Devon	Allchin (1871	Very foliose.
depauperata	Exmoor	C. Padley (1868)	Too curious to omit.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
digitata	Burton	J. M. Barnes (1863)	Digitate at all tips.
d. Stewardsonæ	Lancaster, Moor	Mrs. Stewardson (1875)	,, ,,
excurrens	—	—	All terminals truncate and horned.
fluctuosa cristata	County Antrim	T. Bolton (r.)	A beautifully crested, congested crispate form.
gracilis	—	Col. Jones (r.)	Very gracefully made, normal outline.
grandiceps	Warton Crag	Wearing (1862)	A sturdy ramo cristate form; very vigorous.
g. Padley	—	C. Padley	Somewhat similar.
g. Wills	Dorset	J. Wills (1870)	,, ,,
linearis	—	—	Pinnules very narrow, depauperate.
Lux lunæ	Yorkshire	Miss Wright	Well variegated with white.
medio-deficiens	Kenmore	C. T. Druery (1893)	Central pinnules evenly absent.
polydactyla	Whitharrow	J. M. Barnes (1865)	Robust crested form.
p. Jones	Burton	J. J. Jones (186[illegible])	Fine crested form.
p. Druery	Ayrshire	C. T. Druery (1884)	Fine polydactylous form (original a rogue, but one seedling thoroughbred).

L. PSEUDO-MAS.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
apospora cristata	—	Cropper (r.)	A lovely form of cristatum, finely fimbriate all over, the fimbriations forming prothalli; very "miffy."
congesta cristata	—	Dr. Lyell (r.) (1886)	A dwarf, congested form.
crispa	Wales	—	Dwarf, crispy.
crispata	Levens	J. M. Barnes (1863)	Fronds crispy.
crispa gracilis	—	Dr. Lyell (r.)	A little dwarf gem.
crispa cristata angustata	—	Lang (r.)	A dwarf, congested form of L. p. m. cristata angustata.
cristata	St. Anstell	—	"The King of the Male Ferns," finely tasselled and robust.
c. angustata	—	—	A narrow and smaller form of cristata.
c. Wilson	Langdale	J. A. Wilson (1871)	Fine pendulous cristate form.
c. fimbriata	—	Cropper (r.)	A lovely plumose form of "The King"; a gem.
grandiceps Ranyard	—	—	A splendid form.
lineata furcans	Patterdale	W. Forster (1882)	Pinnule narrow and deeply incised.
Pinderii	Elterwater	G. Pinder (1855)	Resembles Barnesii in Filix-mas.
polydactyla	Several places	Several	Flat-fingered crests.
,,	Westmoreland	Mapplebeck (1862)	Terminals widely divided.
,,	Millom	Rev. W. T. Baker (1884)	Very fine form.
p. Wills	South Devon	Wills	A grand variety.
p. Dadds	—	J. Dadds (1872)	Splendid form, robust.
p. grandiceps	—	J. Dadds (r.)	A heavier crested form of polydactyla Dadds.
ramo-cristata Fitt	—	Fitt (r.)	A ramose form of cristata.
,,	—	Mrs. Wilson (1871)	,, ,,
ramo-furcillata cristata	Langdale	J. A. Wilson (1871)	Very ramose and robust.
ramo-furcillata	North Devon	Dadds (1864)	Ramose and tips forked.
ramosissima	North Wales	R. Wright (1864)	Branches repeatedly into a ball of frondage, barren and beautiful.
ramulosissima	—	Sim (r.) (1865)	A dwarf grandiceps.
revolvens	Troutbeck	Clowes	Fronds in tubes, resembles propinqua in texture.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
Stablerii	—	Stabler	Like Pinderii, but larger.
sub-cristata	North Devon	Dadds (1861)	Tassels small but fronds very wide and graceful outline; a gem.

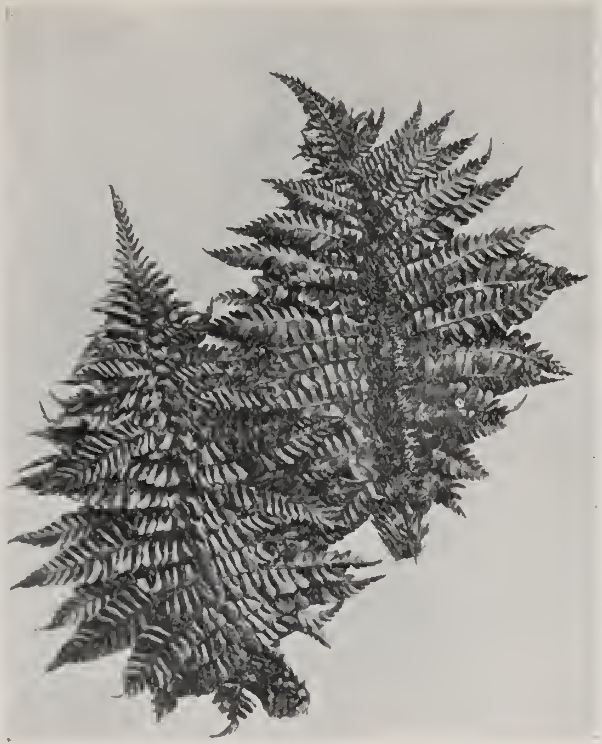
L. PROPINQUA.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
attenuato cristata	Clougha	J. Stewardson	Narrow crested form.
cristata	Several places	Various	All worthy of a place
c. Barnes	Langdale	J. M. Barnes	Very finely crested.
c. Coward	Ambleside	—	Small, neatly crested.
c. Gott	Lowgill	J. Gott	Neatly crested.
crispata incisa	Patterdale	J. J. Smithies (1885)	Pinnules fine cut and crisped.
curvato cristata	Swindale	Barnes (186[illegible])	Pinnules curved downwards.
dactyliferum	,,	,,	A fine polydactylum form.
gracile	Mardale	W. Forster(1865)	Very beautiful narrow pinnules, finely cut.
g. furcans	—	Forster (1887)	Fronds pendent, wide, furcate.
grandiceps	Mardale	J. M. Barnes	Large spreading head.
producta	—	Forster (1887)	Fine slender variety.
pulchella	Patterdale	Forster	Very pretty and slender.
smithiesii	—	—	Pinnules fine cut and crisped.

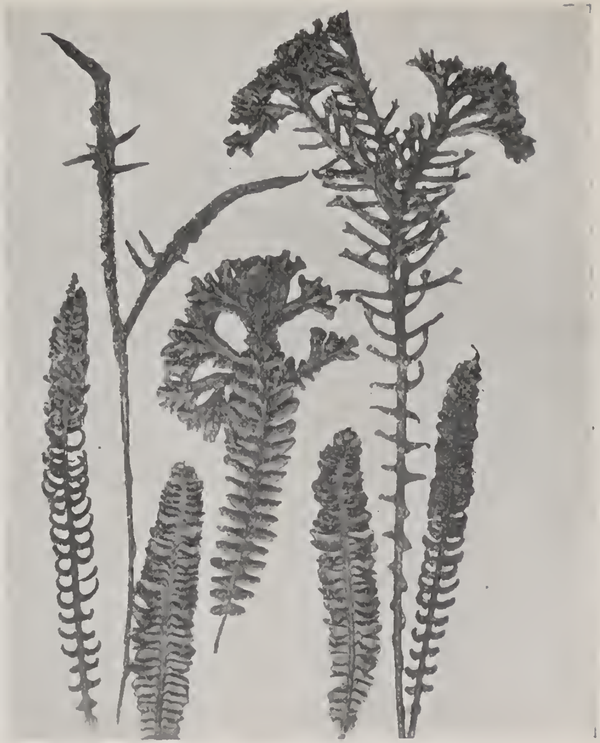
L. DILATATA (THE BROAD BUCKLER FERN).

This Fern differs from the last species in the intense green colour of its fronds and the fact that the basal pinnæ are the most developed, and usually divided thrice, broadening the fronds and justifying its specific and popular names. Its scales are almost black and the midrib bright green. It cannot be confounded with the male Ferns, nor can we agree at all with Mr. Lowe's suggestion that L. œmula is a form of it, as that Fern differs markedly in form of caudex and other constant details of make and appearance. The range of variation in L. dilatata is small, but some forms are very good; soil, peaty loam.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description*
cristata	Clovelly	C. T. Druery (1888)	Slender and neatly crested
c Jackson	—	Jackson	Crested.
c. Oscrofti	Near Bristol	J. Oscroft (1873)	A very finely tasselled form.
c. gracile	Carnarvon	Roberts (1870)	Very pretty and percristate, but with a seemingly incurable tendency to partial depauperation.
foliosa-cristata	Azores	Brown	Two splendidly crested forms and evergreen. As forms of a British species they cannot be ignored; no native find equals them.
f. digitata	,,	,,	
f. grandiceps	—	C. T. Druery (r.)	A heavier crested variety; raised from cristata.
grandiceps	—	Barnes (r.)	A beautiful thing.
Howardi	Yorkshire	Greenwood (1863)	An extraordinary form, pinnules contracted and cruciate pinnæ, consequently very narrow, truncate at tips.
lepidota	—	—	A very pretty, finely-cut form, all parts slender.
l. cristata	—	Stansfield (r.)	Ditto, with tassels.
polydactyla	—	Turner	Many points at tips.
ramo-cristata	—	Barnes (r.)	Ramose and bunch crested.



Lastrea pseudo-mas crispa.



Blechnum spicant vars. imbricatum, heterophyllum, cristatum, and ramo-cristatum.

L. OEMULA (THE HAY-SCENTED FERN).

A small grower, with pretty crispy pinnules and a bunchy caudex. One of our prettiest native Ferns in its normal form and evergreen; its fronds, when dying off, if gathered, have and retain a strong scent of Hay or rather Tonquin Bean. The only really good variety is L. œ. cristata, found in North Devon by W. Gill, and prettily and thoroughly crested.

L. MONTANA (OREOPTERIS) (THE MOUNTAIN BUCKLER FERN).

This species is very abundant on hillsides in mountain districts, but is also found in the lowlands in moist, loamy situations. Superficially it resembles the male Fern, but differs in that the pinnæ commence quite at the base of the frond stalk with simply rounded lobes; the fronds are bipinnate, of a light green, and if passed through the hand give off a remarkable Lemon-like scent quite peculiar to itself; its spore heaps, too, are extremely small, and indusia hardly visible. For many years it had a reputation for peculiar constancy, but eventually its versatility came to light, and it far and away excelled the rest of the genus in the sports it yielded to persistent hunters, Mr. J. M. Barnes in particular. The great majority were found in the Lake District, but this is due, in our opinion, to the residence there of more persevering and experienced hunters, as one of the

LASTREA ŒMULA CRISTATA.

finest crested forms fell to our own lot in Devonshire, where it is far less abundant. Varieties in this species are seldom "roguish," as in the male Ferns, *i.e.*, partial and inconstant.

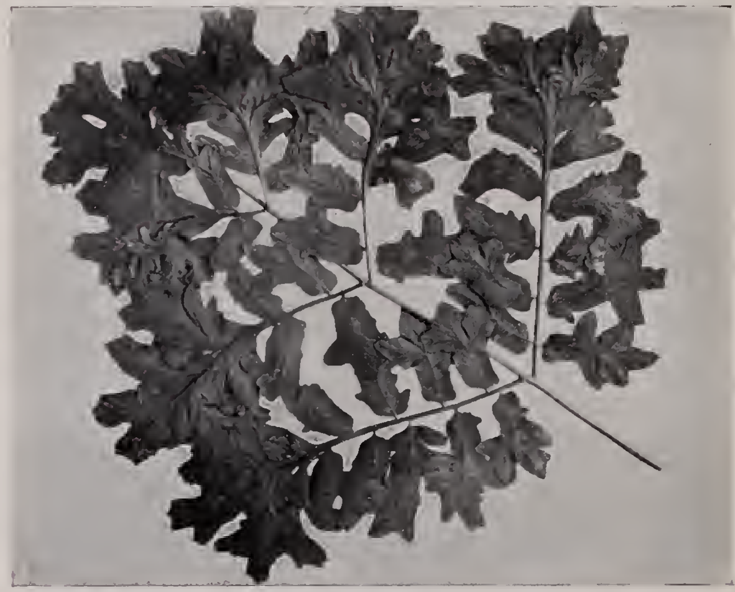
Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
attenuato cristata	Mardale	J. M. Barnes (1865)	Caudate and crested.
Barnesii	—	,,	A most remarkable narrow form, with pinnæ set step fashion on the fronds; one of the uniques when found, but subsequently closely matched by others.
angustifrons	Patterdale	G. Whitwell	Similar to Barnesii.
breviloba	Mardale	J. M. Barnes (1864)	Pinnules evenly reduced.
angusta	Staveley	J. Westlake	,, ,,
apuæformis	Swindale	J. M. Barnes (1865)	Multifid, ramose head.
caudato cristata	Rydal Head	Crouch (1863)	Caudate, small crests.
caudata	Mardale	J. K. Hodgson (1868)	Caudate terminals.
concinnata	Loughrigg	Crouch (1866)	A form of revolvens.
congesta	Langdale	J. M. Barnes (1873)	Densely foliose.
,,	Various	Various	All good forms.
coronans	Langdale	J. M. Barnes (1872)	A splendid crested form.
corymbifera	Grasmere	J. Garnett (1889)	Bunch-crested.
crispatissima	Troutbeck	J. Gott (1880)	Very dense and crispy.
crispata	Clougha	J. Stewartson	Crispate.
crispa	Furness Fell	J. M. Barnes (1865)	Undulate pinnules.
,, Bell	Coniston	Bell (1880)	,, ,,
crispo angustata	Patterdale	W. Forster	Narrow crispy.
crispo congesta	Coniston	J. M. Barnes, jun.	Dense crispy.
cristata angustata	—	J. M. Barnes (r.)	Narrow fine crested.
cristato gracile	North Devon	C. T. Druery (1888)	Slender and finely tasselled.
cristata	Westmoreland	J. M. Barnes (1871)	Finely crested form.
,,	Monmouth	T. H. Thomas	Crested.
curta	Wyresdale	Hartley (1879)	Fronds erect narrow, very pretty.
curvata	Farleton Knots	J. J. Jones (1883)	Pinnae deflexed, frond attenuate.
,,	Garsdale	J. M. Barnes (1866)	Pinnæ deflexed, robust.
,,	Coniston	G. Whitwell (1887)	Similar.
decurrens	Garsdale	J. M. Barnes	Pinnules decurrent.
grandiceps	—	Barnes (r.)	Heavily tasselled.
,,	Martindale	Smithies (1886)	Branching and crested.
plumosa	Little Langdale	T. Airey	True plumosums, grand varieties. Foliose finely cut.
,,	Patterfell	G. Whitwell	
polydactyla	Various	Various	Terminals many pointed.
ramo-coronans	—	Barnes (r.)	Branched and crested.
ramo-cristata	—	,, (r.)	,, ,,
revolvens	—	—	*See* concinnata.
truncata	Many	Many	All terminals truncate and horned, curious but worth having; should be called "excurrens."
furcillata	Frostrow	G. Whitwell (1879)	Furcillate tips.
filifera	—	J. Wiper (r.)	Most remarkable form, pinnules deeply incised with long attenuate points, bulbiferous at base.
gracilis	Hawkshead	J. Wiper (1889)	Finely incised pinnules.
latifolium	Cautley	G. Whitwell (1882)	Broad fronded, robust.
reflexa	Coniston	J. Stewardson (1881)	Pinnæ like ringlets.
simplex	Mardale	J. M. Barnes (1867)	Pinnæ simple, resembles P. vulgare.
stricta-Whitwell	Cautley	G. Whitwell (1882)	Fronds very narrow.

OPHIOGLOSSUM VULGATUM (THE ADDER'S-TONGUE).

THIS is one of the most inconspicuous of all Ferns, and exists probably in many places where it is unsuspected, as it grows in quantities in some pasture lands among the grass, and looks very like a single leaf of the common Plantain weed, with a short seed-spike of the same weed projecting from its centre, like a serpent's tongue, whence both its botanical and common names. It has a creeping root-stock, and if lifted *en masse* and transferred to a shady position in a garden will come up year after year. Two varieties are recorded, of which O. v. lusitanicum, a dwarf form, may be mentioned as possibly specifically distinct. No decorative value at all.

OSMUNDA REGALIS (THE ROYAL FERN).

OF this there is only the one native species, commonly called also the flowering Fern, owing to a superficial resemblance to a Spiræa-like scape at the tips of the fertile fronds, in which



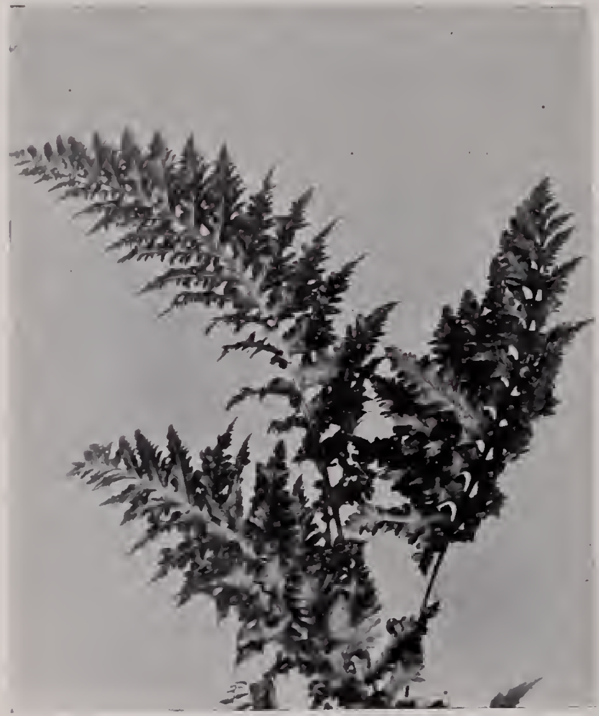
OSMUNDA REGALIS CRISTATA.

the terminal pinnæ and tip are contracted into mere midribs bearing bunches of sori or spore heaps. It is noteworthy that the spores are bright green when ripe, and are shed very early, so that when the masses of sori look brown and ripe it is usually too late to obtain spores in any number. The Fern is, perhaps, our largest, forming, in its favourite habitats, on river banks or islands, dense coppice-like groves capable of affording cover even to a horseman. In such places it will be found that the ground is a dense spongy mass of Moss and Fern caudices, the Osmunda forming large rounded masses of aerial roots, as well as terrestrial ones. Hence in cultivation it must be treated as a bog Fern; soil mainly peat, and water in plenty. It is quite deciduous, the fronds disappearing entirely in the winter. It has not been at all prolific in varieties, the only really fine one being O. r. cristata (page 64), which found its way to a nursery in the winter time in a batch of common ones, and thus deprived its finder of the thrill of delight its discovery should have afforded, and leaving that pleasure to Mr. G. B. Wollaston, who "spotted" it afterwards at the nursery for the first time, but failed to become its owner, despite a bid of £25, for those were the happy days when British Ferns were appreciated, and the nurseryman knew it. Under cultivation it has yielded some sub-varieties, one of which bears bulbils, and another has ramose fronds, as well as the beautiful crests peculiar to the find. Curiously enough the Japanese form of the same species has also yielded a pretty but smaller form, O. j. corymbifera, which makes a pretty pot plant, but is not so hardy or robust. Spores germinate freely and yield abundant plants true to type, but they take years to reach a fair size. O. r. undulata, found abroad, crispy and pinnæ undulate. O. r. rotundata, Ireland, Phillips; pinnules rounded. In addition to the above, a very fine form, O. r. decomposita, has been found in Ireland, in 1901, by Mr. Cowan. This has the usually smooth-edged pinnules deeply crenate at the base of the fronds, and becoming more and more divided towards the tip until complete pinnulets are formed. The fertile portion consists also of detached bead-like, instead of slightly crenate, spikelets.

THE POLYPODIES.

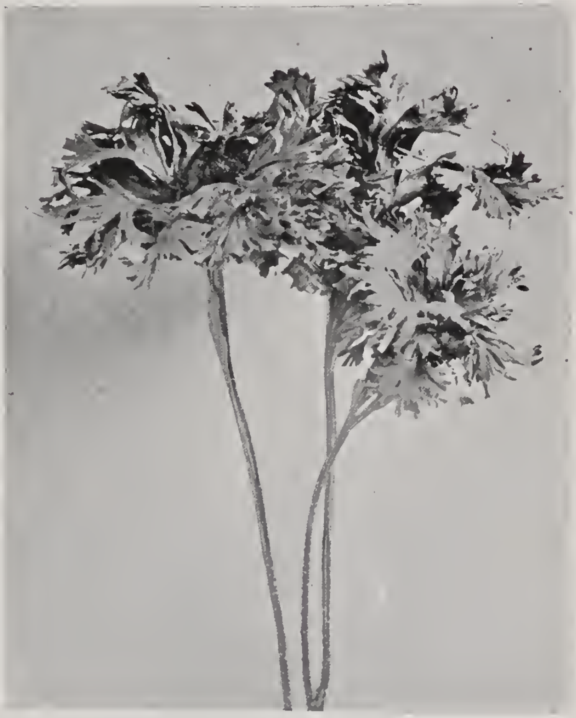
THE COMMON POLYPODY (POLYPODIUM VULGARE).

POLYPODIUM VULGARE is one of a big family, whose spore heaps are round, or nearly so, and quite destitute of a cover or indusium. The generic name implies, however, "many footed," and therefore refers to another feature altogether, viz., the creeping root-stock, which, however, is found in many genera of entirely distinct character, and therefore by itself gives no clue to species. In Great Britain we have four members of the family, viz., P. vulgare (the common Polypody), P. dryopteris (the Oak Fern), P. phegopteris (the Beech Fern), and P. calcareum (the Limestone Polypody). P. alpestre, so-called because its spores have no indusium, no fernist can accept as other than an Athyrium, especially as in many Athyria the indusium becomes almost or quite a nullity. Among these species P. vulgare stands absolutely distinct; its creeping root-stock is thick and fleshy; its fronds, simply pinnate, are



P. VULGARE PLUMOSUM HADWINII.

dark green and tough; its spore heaps and spores are large and yellow, and it is, finally, a thorough evergreen, while, on the other hand, the other three have twice-divided fronds of very delicate make and colour springing from dark, slender, stringy rootstocks; spore heaps and spores are small and dark-coloured, and finally, again, all three species are perfectly deciduous. Then, too, Nature has determined another great difference, since while the three of a kind have only given us two or three varieties, none of very marked character, the other, P. vulgare, has been most generous and donned the gayest and happiest garbs for the Fern hunter's delectation In this respect, indeed, like others of our British Ferns, it has put all its exotic relatives to the blush by producing far more distinct and beautiful varieties than all the rest of the family together. It has even gone a step farther, and by lending some of its blood to its stately cousin, P. aureum, has given us P. Schneiderii, an edition of P. v. elegantissimum enlarged to the utmost, and a triumph of hybridisation. P. vulgare is found all over Great Britain; old walls, old trees, rocks, and hedgerows are its favourite habitats, and well-rotted leaf-mould its favourite soil. In culture it does best in large, well-drained, shallow pans filled with a loose leafy and peaty



P. VULGARE VAR. GRANDICEPS PARKER.

compost, into which the creeping rhizomes can embed themselves on the surface and ramble freely. It also does splendidly when installed in suspended wire baskets, displaying itself, perhaps, to the best possible advantage when so treated and not allowed to dry out. When once properly installed, the less the plant is disturbed the better the growth, and, under such circumstances, what this normally mediocre-looking plant can do in its varietal forms is simply astounding. It loves light and air, as we may judge by its haunts, and can even stand a fair amount of sun if drought be avoided.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
bifido-multifidum	Grange	Walmsley (1867)	Long narrow fronds bifid, pinnæ, broad crested head.
cambricum	Many	Many	The plumose form of the species, splendidly foliose, quite barren, and the pinnæ divided into long, overlapping segments. The three first-named forms are distinct in detail, and by far the finest. Oakleyæ is a dwarf edition. All are gems. Hadwinii is distinguished by obtuse tipped segments (page 66.); Prestonii has them longer and very acute
c. Barrowii	Witherslack	Barrow (1874)	
c. Hadwinii	Silverdale	Hadwin (1875)	
c. Oakeleyæ	Raglan	Oakeley (1868)	
c. Prestonii	Yelland	Preston (1871)	
cornubiense (elegantissimum)	Cornwall	Whyte and others (1867)	Very finely divided into linear segments; usually reverts erratically to normal in places. Fertile, but the improved forms were all, we believe, raised from divisions.
c. foliosum	—	Clapham (r.)	More finely divided; apt to get coarse.
c. Fowlerii	—	Fowler (r.)	
c. plumosa	—	Barnes (r.)	Fronds broader and more foliose, but finely cut.
c. trichomanoides	—	Backhouse	Elegantissimum kept true by selection. Probably the best of all the section; a gem.
cristatum	County Cork	Perry (1854)	Prettily crested at all tips. (Page 67.)
c. Morleyii	—	Morley	Crested, but less markedly.
glomeratum	Dorset	Mullins (1873)	Curiously and broadly ramose in all fronds, coarse.
grandiceps Forster	—	Clewarth (1876)	Heavily tasselled, capitate head. Two finest forms, quite distinct.
g. Fox	Grange	Mrs. Fox (1868)	
g. Parker	Somerset	Parker (1854)	Huge spreading, terminal crests, with crispy tips, often no pinnæ; unique.
Hutchisonii	Carmarthen	Hutchison (1889)	Resembles trichomanoides, with lax apex.
longipinnatum	Killarney	Druery	Very long, attenuate pinnules; frond 6 inches wide.
macrostachya	County Clare	O'Kelly	Very distinct and constant; upper third of frond undivided caudate.
multifido elegantissimum	—	Clapham (r.)	A cross between cornubiense and bifido-cristatum, *i.e.*, a crested cornubiense.
omnilacerum Aldrenii	Milnthorp	Aldren (1873)	Grand divided variety when in form, but very rarely seen so.

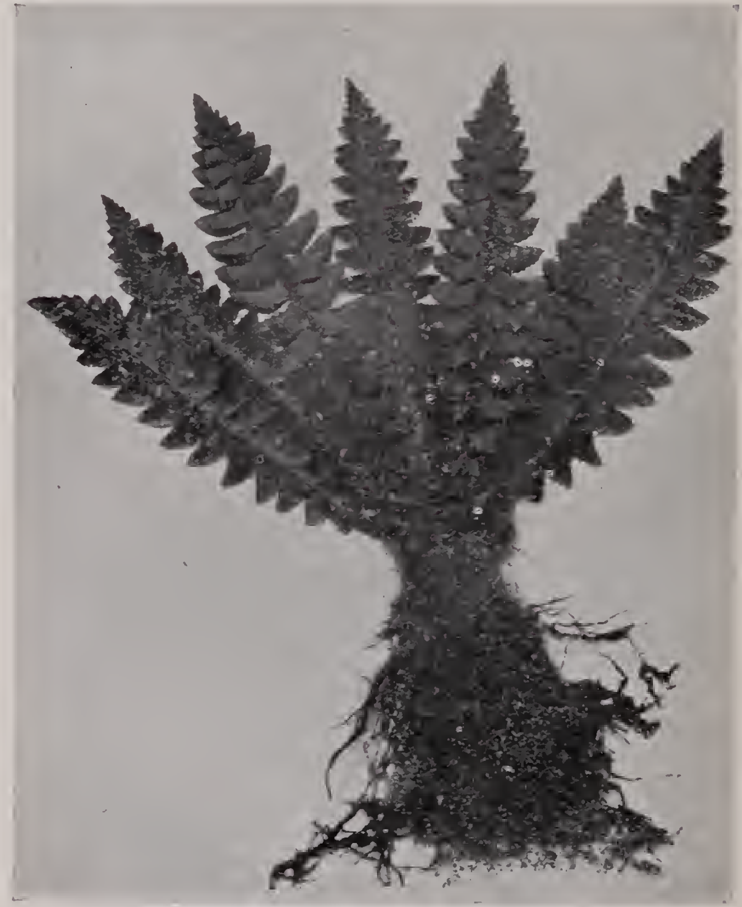
Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
omnilacerum Bennett	Goodrich Castle.	Bennett (1848)	Very fine; far better than last when in form.
o. superbum	Cornwall	Williams (1900)	A magnificent form; robust; pinnules 2 inches long.
pluma	Tintern	Cowburn (1861)	Intermediate between cambricum and pulcherrimum; slightly fertile.
pulcherrimum	Whitbarrow	Addison (1861)	A splendid tripinnatifid variety *à la* cambricum, but coarser and fertile.
ramosum	Hants	Hillman (1860)	Branches repeatedly; nice form.
r. Watson	—	Watson	,, ,,
semilacerum	Several	Several	Twice divided, bipinnatifid.
s. grande	Wicklow	(1862)	A magnificent form; fronds finely cut, circular, and huge, 12 inches across.
s. Loweii	Athlone	Col. Lowe	Dense imbricate.
s. robustum	Whitbarrow	Barnes (1863)	Splendid foliose form.
s. truncatum	Levens	J. M. Barnes (1863)	Frond and pinnæ truncate and horned.
s. undulatum	—	—	Densely lobed.
erra	Lancs.	Wilson	Fine foliose, serrate form.

THE BEECH FERN (P. PHEGOPTERIS) AND OAK FERN (P. DRYOPTERIS).

The Beech Fern and Oak Fern, the latter especially, form charming specimens if grown in pans in loose leafy compost.

P. DRYOPTERIS (OAK FERN).

The soft moonshiny green of the Oak Fern, coupled with its pretty habit, constitute it one of those rarities which even the veriest variety hunter hardly wishes to see other than it is in its native simplicity. It does splendidly in a Wardian case given plenty of light but no sun. There are no varieties. The Beech Fern has afforded one worth noting, viz.:

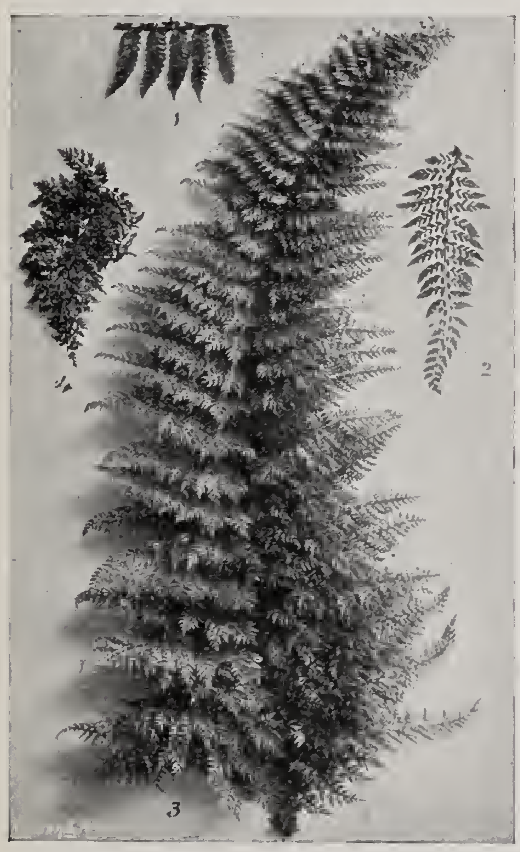


Polystichum lonchitis (Holly Fern).

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
multifidum	Burton	J. Jones	Slightly but constantly multifid at tips of fronds.

THE POLYSTICHUMS (THE SHIELD FERNS).

IN Great Britain we have three species of this genus, viz., P. lonchitis (the Holly Fern), P. aculeatum (the Hard Shield Fern), and P. angulare (the Soft Shield Fern), and it is a very curious fact that though there are numerous exotic species, the varietal forms of these are extremely few, while, especially in the two last-named, an immense number of distinct forms have been found wild, and even P. lonchitis, limited as it is in range, has afforded several. All three species are thoroughly evergreen, and the whole genus is peculiar in the fact that normally the pinnules are shaped something like a fingerless glove, the thumb sticking out at almost right angles to the other portion, and more or less acute points terminating the divisions. In the abnormal forms this feature usually persists, though the make of the pinnules is varied to the utmost. In the Holly Fern we have the simplest form, the frond consisting merely of two rows of undivided glove-shaped divisions, which in this case form pinnæ. In the other species, which are usually of much larger growth, the



POLYSTICHUM ANGULARE VAR. PLUMOSUM DENSUM. 1. THE NORMAL FORM OF SPECIES. 2. WILD FIND IN SOUTH DEVON. 3. FROND OF DENSUM RAISED FROM 2. 4. PINNÆ OF IMBRICATUM RAISED FROM BULBIL OF DENSUM.

pinnæ are composed of two rows, the frond being thus twice divided instead of only once, but in many of the varieties division is carried to the fourth and even fifth degree, the ultimate division becoming smaller and smaller as division proceeds, but still maintaining the characteristic structural plan almost invariably. The Holly Fern (page 70) in this country is entirely a mountain species, usually frequenting hills at 2,000 feet to 3,000 feet elevation. We have, however, found it in Scotland at about 1,200 feet, a marked exception to the rule.

The other two species are common in our western counties, from south to north of England, and in the south of Scotland. P. aculeatum extends further north than P. angulare, which in Scotland is rare, due doubtless to the fact that it has a greater predilection for warmth. In Ireland both species are plentiful, and many of our finest forms have been found there by Mr. W. H. Phillips and others. They thrive best in sheltered situations, and P. angulare especially frequents hedgerows, where it is usually associated with the Hart's-tongue. A good loamy leafy compost suits both species well. Under glass plenty of air must be given, as if coddled the fronds of many of the finely-divided forms go wrong at the tips, a sort of fungus growth developing among the densely-crowded coils of the unrolling fronds.

The sori or spore heaps are round, and covered by a a small circular mushroom-shaped scale attached by its centre, shield fashion, whence the name of the genus. It thus differs from the Lastreas, in which this scale is distinctly kidney-shaped, and attached at the point of the depression. Nevertheless, botanically, both genera are lumped as Aspidium, forming one of those associations for which the practical cultivator finds little justification, so essentially different are the families as he knows them. As regards the Holly Fern, it is not so amenable to culture as the others, but we have found it to succeed if planted in peaty, rubbly, leaf-mould, under the lee of a large piece of rock or burr facing the north, in a position where it is secure from root drought.

P. LONCHITIS (THE HOLLY FERN).

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
cristatum	Ben Qui	Dr. Craig	Finely crested frond tips.
imbricatum	Scotland and Ireland	Boyd	Pinnæ densely overlapping.

P. ACULEATUM (THE HARD SHIELD FERN).

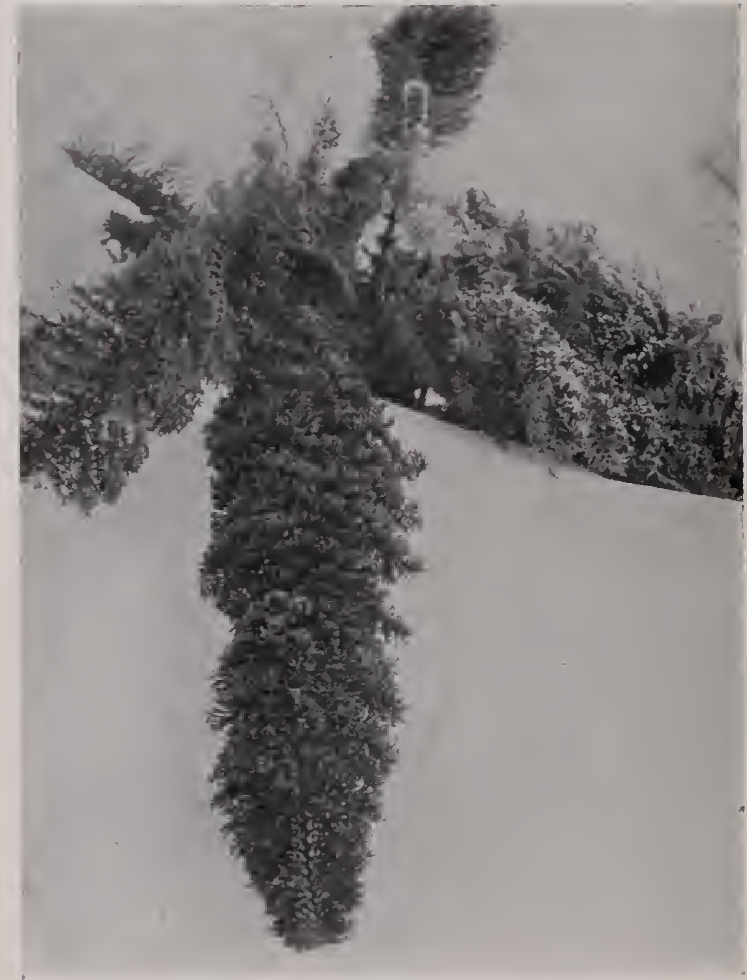
Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
acrocladon	South Devon	Mrs. Agar Thompson (1855)	Densely crested at tips, but not like A. f. f. acrocladon; very fine ramose.
acutilobum (Woll)	—	Allchin (1853)	An acutely lobed lax proliferum.
capitatum	—	—	Heavy capitate head.
corymbiferum	—	E. F. Fox (r.)	Corymbose head.
cristate gracile	Hutton Reef	Bolton (1865)	Very spiny, crested.
densum	Devon	Jackson	Very foliose.
grandiceps Abbottæ	—	Mrs. Abbott	A splendidly crested form.
hybridum aculeato cruciatum Lowe	Lancashire	E. J. Lowe (r.) (1878)	A narrowed, cruciate form, an incontestable cross between P. ang. Wakleyanum and P. ac. densum; a most striking hybrid.
pulcherrimum	Dorset	Bevis (1876)	An unique beauty; long, attenuate, silken divisions, delicately imbricate at frond tips, almost always barren, but liberal in offsets; well named the "beautiful."

P. ANGULARE (THE SOFT SHIELD FERN).

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
acrocladon	South Devon	J. F. Mapplebeck (1862)	Very ramose, *à la* A. f. f. acrocladon, but not so dense growing.
acutilobum Gray	South Devon	R. J. Gray (1865)	Fronds much divided, lobes long, and very acutely pointed, forming a distinct and beautiful section, which embraces all the most proliferous forms known as "proliferum," an objectionable sectional term, so many varieties of other sections being also proliferous to some extent.
a. Hartley	Furness Fell	Mrs. Hartley (1863)	
a. Phillips	County Down	W. H. Phillips	
a. Wollaston	—	Wollaston (r.)	
a. proliferum Allchin	—	Allchin	
a. p. Choule	—	Choule	
a. p. Dadds	—	Dadds	
a. p. Footii	County Clare	F. Foot	
a. p. Wells	Dorset	Wells (1876)	
a. p. Wollastoneii	South Devon	G. B. Wollaston (1852)	
apuæforme	Cunsey	Mrs. Wilson 1863)	Fish-shaped, crested.
Baldwinii	—	—	*See* plumoso divisilobum.
brachiato-cristatum Keall	—	Keall	Most curious form, fronds branch into three, trident-fashion, each branch crested. Keall's is the most marked find, but several others exist.
Bradburyanum	—	—	*See* grandiceps.
capitosum	Tatworth	Moly	Narrow grandiceps, heavy head.
conchatum	Hawkhouse	Moly	Pinnules like shells.
confluens Foot	Ireland	S. Foot	Very slender confluens, pinnæ like lineare.
c. Moly	South Devon	Moly (1873)	,, ,,
congestum Lycll	—	Lycll (r.)	A dwarf, congested gem.
c. Padley	South Devon	Padley (1865)	Densely congested and imbricate.
c. Wills	—	Wills	Congested, dwarf, and fine.
c. grandiceps	—	Birkenhead	Heavy crests, congested.
conspicuilobum	Dorset	Wills (1878)	The "thumb" of the pinnules very conspicuous.
crawfordianum	—	—	*See* acutilobum proliferum.
cristatum Carbonell	—	Carbonell (r.)	Slender, crested form.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
cristatum Wollaston No. 10	Somerset	G. B. Wollaston	Beautiful, fine flat spreading terminal tassels, side ones small.
cristata gracile percristatum Barnes	Witherslack	Barnes	All beautiful, even the pinnules being crested; terminal crests small and neat; Molys form the finest.
c. g. p. Gray	—	Gray	
c. g. p. Jackson	—	Jackson	
c. g. p. Moly	—	Moly	
crispata foliosum Parsons	Danesbury	Parsons (r.) (1872)	A great beauty, setose crispy and dense.
decompositum grande	Torquay	Colonel Jones (1870)	Grand, much divided form.
d. magnificum	—	Colonel Jones (r.)	Similar, but distinct.
d. Phillips	County Down	W. H. Phillips	Much divided.
d. splendens	—	Colonel Jones (r.)	Similar, but distinct.
,, Moly	South Devon	Moly (1875)	Beautiful, parent of the marvellous plumose divisilobes of Jones and Fox.
deltoideo-decompositum	Devon	Moly (1874)	Fine broad based decompositum.
densum	—	—	*See* plumose divisilobum.
divisilobum	—	—	Fronds much and distinctly divided, one of the finest sections, viz.:
d. Elworthy	Somerset	Elworthy (1852)	Very good.
d. Henleyæ	Somerset	J. Bagg (1869)	A fine proliferous form.
d Holcanæ	South Devon	J. Plumsoll (1861)	,, ,,
d. Moly	South Devon	Moly (1875)	A beautiful divisilobe.
d. Padley	North Devon	Padley (1866)	One of the finest of the section.
d. Seymour	South Devon	Miss Seymour (1870)	A dense fine form.
d. acutum	—	Padley	Lax and very fine.
d. cristatum Ivery	—	Ivery (r.) (1870)	One of the finest, richly crested.
d. crawfordianum	Crawford, Iburn	Phillips	A beautiful proliferum.
d. decorum	—	Jones (r.)	Finely divided.
d. d. polydactylum	—	Stansfield (r.)	Finely divided and crested.
d. densum Stansfield	—	Stansfield (r.)	Resembles plumose divisilobes.
d. elegans	—	Birkenhead (r.)	Finely divided.
d. falcatum	—	Moly	Long lax falcate pinnæ and pinnules.
d. foliosum	—	Birkenhead (r.)	Foliose.
d. grande Jones	—	Jones (r.)	Very fine.
d. g. Stansfield	—	F. W. Stansfield (r)	Broad triangular fronds, distinct.
d. grandiceps	—	Carbonell (r.)	Heavy crested head.
d. imbricatum	—	Birkenhead (r)	Dense.
d. laxum Phillips	Castle Coole	Phillips	Very fine.
d. l. Wills	South Devon	Wills (1874)	A lax beauty.
d. longipinnatum.	—	Carbonell	Lax and graceful, lower pinnules very long.
d. multifidum	—	Jones (r.)	A multifid form.
d. intescens Jones	—	Jones	Exceedingly neat, dwarf.
d. perfectum Jones	—	Jones (r.)	Well-named; lovely.
d. plenum	—	Jones (r.)	Very fine.
d. productum Fox	—	Fox	,,
d. quadripinnatum	—	Jones	,,
d. robustum Moly	South Devon	Moly (1874)	Splendid, perhaps the largest of all.
d. stipulatum	—	Carbonell	A beautiful imbricate form.
flabellipinnulum	Dorset	Wills (1878)	Pinnules fan-shaped, rather inconstant.
flexuosum Wollaston	Somerset	Wollaston (1870-73)	Fronds curiously twisted.
folioso-latipes	Devon	Parsons (1871)	Fine foliose form.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
folioso-multifidum	—	—	Round pinnules, heavy crest.
frondosum Jones	—	Jones	Densely foliose.
frondoso-bulbiferum Jones	—	Jones	Fine foliose proliferum.
f. decompositimo	—	—	Foliose and much divided.
gracile Gray	South Devon	R. J. Gray (1865)	Slender, acutely lobed.
g. Padley	—	Padley	A finer form of same.
g. Wollaston	South Devon	Wollaston (1856)	,, ,,
grandiceps Barraud	Barnstaple	Barraud (1889)	Heavy head, almost bare stalks.
g. Bradbury	—	—	A good heavy-crested form.
g. J. Jones	Pembroke	J. Jones (1869)	Splendid form.
g. Moly	Somerset	Moly (1869)	,, ,,
g. Talbot	County Cork	W. Talbot (1861)	,, ,,
grandidens Fitt	—	Fitt (r.)	A very fine crispate grandidens.
g. Pearson	—	Pearson (r.)	Very finely cut, raised from Pearson's plumosum.
hirondelle	Dorset	Wills	Small lineare form, with with swallow-tail pinnules.
imbricatum	Somerset	Elworthy	Narrow, imbricate, proliferus.
imbricato-crispatum	—	—	Overlapping and crispy.
inequale variegatum Padley	—	Padley	Unique, speckled with pure white and contracted in conjunction with the variegation, but not enough to spoil it.
i. v. polydactylum	—	Jones	An unique cross with polydactylum, speckling exactly reproduced, and inequale character much reduced.
latifolium	South Devon	Moly (1873)	Very fine, long lower pinnules.
latifolio-grandiceps	—	Jones (r.)	Broad fronded, heavy crested
latipes	—	Parsons (r.) (1876)	Broad based foliose, fine.
laxo-cristatum Praeger	Castle Dobbs	Praeger (1885)	Lax and crested.
lineare Jackson	—	Jackson	All with very slender pinnæ and much reduced, pinnules generally confluent at terminals, giving a very graceful appearance.
l. James	Guernsey	James	
l. Moly	South Devon	Moly (1873)	
l. nidum	—	E. J. Lowe	
l. Tait	—	Tait	
l. Wells	—	Wells (1871)	
Lyellii	—	—	*See* congestum Lyell.
manica-infantis (Woll)	Offwell	Moly	Pinnules like a baby's glove, a conspicuilobe.
multilobum	South Devon	Gray (1865)	A fine tripinnate form.
m. attenuatum	—	—	Splendid tripinnate form, very like Divisilobum productum.
m. decorum	—	—	Splendid tripinnate form.
m. densum	—	—	,, ,,
m. Iona	Iona	Jones	A fine multilobe.
m. laxum	Teignmouth	Jones (1872)	A lax multilobe.
m. ovale	Somerset	Padley (1863)	Robust, lax, and elegant.
m. plumosum magnificum	—	Birkenhead	Very fine form.
obtusissimum	Ottery St Mary	G. B. Wollaston (1861)	Imbricate; pinnules blunt; handsome.
parvissimum	Exeter	Veitch (r.)	Neat and pretty, but misnamed, as others are smaller.
pendens Wills	—	Wills	A broad-fronded, lax form; very fine.
percristatum Moly	—	—	*See* cristato-gracile.
p. Wills	—	—	,, ,,



POLYSTICHUM ANGULARE PLUMOSISSIMUM (BIRKENHEAD).

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
perserratum Baylæ	—	Bailey	All three very delicate, deeply cut, and setose forms; very beautiful.
p. Patey	Berks	Patey (1873)	
p. Wollaston	South Devon	Wollaston (1869)	,, ,,
plumoso-divisolobum	—	—	A sectional term, embracing the best, viz.:—
p.-d. grande	—	Fox (r.)	A cross between decomp. splendens and plumosum Wollaston; a grand foliose form.
p.-d. tenue	—	Fox (r.)	Another beauty; slenderer make.
p.-d. Baldwinii	—	Jones and Fox (r.)	Incomparably the finest plumose forms of the species, raised from decomp. splendens of Moly, a merely decomposite sport, occasionally sparsely fertile and bulbiferous. Baldwinii is the finest cut, and unique.
p.-d. densum	—	,, ,, ,,	
p.-d. imbricatum	—	,, ,, ,,	
p.-d. laxum	—	,, ,, ,,	
p.-d. robustum	—	,, ,, ,,	
p.-d. dissectum	—	Pearson (r.)	All three akin to the above and very beautiful.
p.-d. foliosum	—	,, ,,	
p.-d. Pearson	—	,, ,,	
p.-d. Grimmondii	Scotland	—	Similar; splendid form.
p.-d. Esplan	—	—	Rivals all but Baldwinii; quite distinct in its starfish-like habits; origin foggy.
plumosum Elworthy	Somerset	Elworthy (1856)	Very beautiful and distinct.
p. Moly	—	Moly	Very fine form, reputedly barren.
p. Patey	Dorset	Patey	A true plumosum; a gem, rarely fertile.
p. Wollaston	Devon	G. B. Wollaston	A grand, fertile plumosum.
p. grande	—	Fox (r.)	Splendid, robust.
p. perfectum	—	Birkenhead (r.)	,, ,,
p. splendens	—	Col. Jones (r.)	,, ,,
plumosissimum	—	Birkenhead (r.)	The latest departure. In addition to the finest plumoso divisilobe character, all the ultimate divisions extend into long, tongue-like tails, piling up a moss-like growth upon the frond. A type of apospory; unique
polydactylum Jones	Hampshire	Jones (1875)	Fine polydactylous.
p. Wills	—	Wills	,, ,,
p. splendens	—	Jones (r.)	A better form; foliose and crested.
p. Wollaston	Somerset	Wollaston (1870)	Small side crests; large, spreading head.
Praegerii	Castle Dobbs	Praeger (1885)	*See* laxo-cristatum.
proliferum	—	—	*See* acutilobum proliferum.
pteropherum	Nettlecombe	Elworthy	Pinnules congested on pinnæ, resembling wings.
pulcherrimum Moly	—	Moly	A very beautiful type when in form, with long, falcate lower pinnules, the points of which run out into prothalli (apospory); the sites of the sori are also usually prothalliferous. The first four are all apt to revert wholly or partially. The last is unique, constant, and boldly variegated yellow and green; aposporous progeny of all mostly depauperate and ugly weaklings.
p. Padley	North Devon	Padley	
p. Thompson	South Devon	Thompson (1863)	
p. Wills	—	Wills	
p. polydactylum	—	Stansfield (r.)	
p. variegatum Moly	—	Moly	

Name.	*Where Found or Raised*	*Finder or Raiser and Date.*	*Description.*
remoto-decurrens	South Devon	Padley	Broad, pinnuled confluens; thorny.
revolvens	Somerset and elsewhere	Wills (1872) and others	Fronds revolute, forming tubes; very graceful.
rotundatum Elworthy	Somerset	Elworthy	Peculiar and pretty; pinnules smoothly rounded, with little trace of the specific mitten shape.
r. Hodgson	Leece	Mrs. Hodgson	
r. Phillips	Antrim	Phillips (1877)	
rotundato capitatum Barnes	—	Barnes (r.)	Round pinnuled, large crests.
r. cruciatum	—	Lowe (r.)	Successful crosses between cruciatum and rotundatum; cruciate pinnæ, rounded pinnules.
r. c. Hankey	—	Hankey (r.)	
setoso cristatum	South Devon	Moly (1874)	A bristly cristatum; a gem.
s. cuneatum	Antrim	Phillips	A gem; beautiful lax form, like a lax perserratum.
s. gracile	Castle Coole	,,	A slender setosum.
stipitatum Carbonell	—	Carbonell (r.)	Beautifully divided; long, attenuate pinnules.
Thompsonæ	North Devon	Mrs. Thompson (1860)	A narrow-fronded grandiceps; seedlings start *à la* acrocladon, and alter materially as adults; a curious case.
tripinnatum Gillett	Yeovil	Gillett (1864)	All beautifully thrice divided, but distinct from each other.
t. Millett	—	—	
t. Padley	—	—	
venustum	—	Padley	A handsome multilobe.
v. cristatum		—	Ditto; crested.
Wakeleyanum	South Devon	Mrs. Wakeley (186[illegible])	Narrow, cruciate fronds, crested at tips; an unique find.

PTERIS AQUILINA.

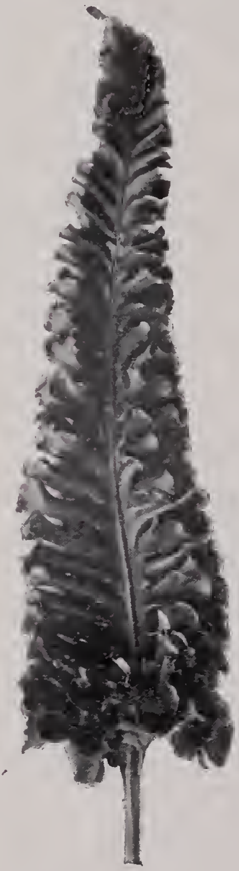
(THE COMMON BRAKE OR BRACKEN.)

THIS grand Fern is so common as to need no description, thousands of acres are covered by it, even in districts otherwise Fernless. Hence we will save our space for its varieties and peculiarities. In the first place, it is the only member we have of a very large family, and is botanically distinguished by its spore heaps being arranged along the edges of the pinnules and protected by such edges being rolled back to cover them. It is one of the most difficult Ferns to remove, its long rambling stolons penetrating to considerable depths, and usually losing their roots proper altogether in the process of lifting. On the other hand, it is one of the easiest and rapidest Ferns to raise from spores, autumn-sown spores yielding strong plants, with fronds 1 foot to 2 feet high, the following season. Raised thus in pots or pans, and planted out in the open in the late summer, they will harden off, and come up robustly the following year; kept in the pot or pan and allowed to get frozen in the winter they are almost infallibly killed, hardy as they are when once established and toughened by the exposure natural to them. This Fern varies considerably, and has yielded some very fine forms. In Surrey we were recently shown some acres of a splendidly-tasselled type, shoulder high and pendulous with beautiful crests, a delightful sight. Three forms are almost ubiquitous, the common flat form, a crispate form, and a finely-cut form, while partially multifid types are common; thoroughbreds, however, are rare. The best are:—

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
congesta	—	—	A splendid dense crispy form, very handsome.
cristata	Several	Several places	All tips beautifully tasselled.
glomerata	—	—	An extraordinary form, fronds flexuose, and all pinnæ rolled up into balls or twisted into knots.
g. cristata	—	—	A cross with cristata, but the cresting is hidden by the rolled up character, and is only seen when unrolled.
grandiceps	—	(r.)	Very heavy crests, barren.
variegata	County Derry	Kyle	Splashed with pure white.

SCOLOPENDRIUM VULGARE (THE HART'S-TONGUE).

THE Hart's-tongue, normally, is one of the simplest Ferns in form, its fronds being plain, flat, and strap-like, commencing at the base with a short, dark-coloured stalk, whence the leafy portion starts with two rounded lobes, continues for some distance with parallel sides, and then gradually tapers to a blunt terminal point, the whole resembling a two-edged carving knife. A dozen or more such fronds, springing radially from a centre, and varying in length from a few inches to nearly a yard, constitutes the material out of which Nature has fashioned more varieties than any other known Fern can boast of, while in the hands of the cultivator, it has varied so much more as to render selection an extremely difficult task. This tendency to vary is the more remarkable, as the species is undoubtedly closely allied to the Asplenia, which vary little, the kinship being proved by an undoubted hybrid, raised by Mr. E. J. Lowe, between the Hart's-tongue and A. ceterach. There are also many other Ferns in the world which bear similarly simple undivided fronds, but none of the species have afforded many sports. Nature—for as usual the wild finds constitute the cultivator's starting point—in this Fern has varied every feature; the normally single stalk and rachis is split up and multiplied in a practical infinity of ways, culminating in Kelway's densum, a veritable ball of moss, the rounded lobes at the bottom she has expanded, lengthened, and tasselled, and even given them the importance of individual fronds, the plain flat strap she has elaborated into ornate frills, and the simple straight edges into deeply-cut fringes, the bluntly pointed frond tip has in one direction been expanded into finely-divided tassels, and in another abruptly cut off and finished up with cups and rosettes and thorns behind or before, the smooth surfaces above or below she has broken up into linear ridges or decked with rough excrescences in many varied styles, and, finally, having seemingly exhausted her ingenuity of plan in all these special particulars, she combines several of the various eccentricities in one and the same individual, and, with Mr. Lowe as her ally, stamps the features of a dozen diverse parents upon one and the same fortunate, or unfortunate, plant, not always to the enhancement of its charms. Even the normally green colour is varied, and striped with white or yellow; but as every example acquired by the editor has lost its variegation when shifted, it appears that a thoroughbred variegated form is still a desideratum. The Hart's-tongue is peculiarly indiscriminate in its habitats, but likes some lime in the soil. Hence it is usually plentiful on limestone formations, and we also find it growing in profusion in a small state on old walls, where, of course, it gets plenty of this mineral in the mortar; on the other hand, however, we find it attaining its largest size in hedgerows and in woods, where its source of lime supply is not so evident. Generally speaking, it is locally associated with the soft Shield Fern, and, like that species, is

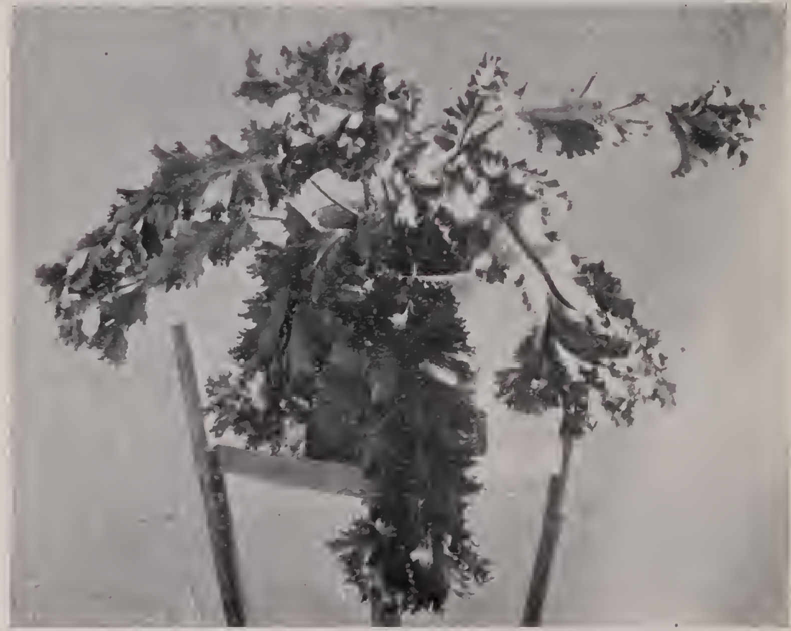


SCOL. V. CRISPUM.

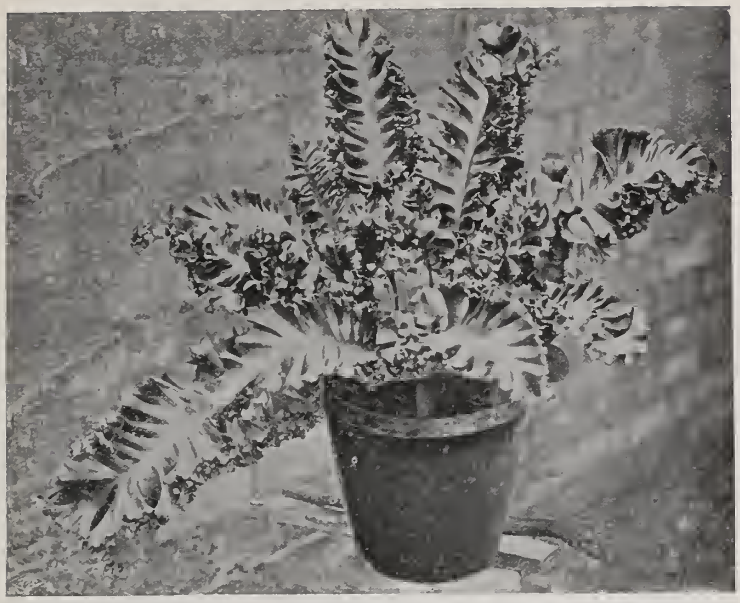
rare in Scotland, otherwise it is pretty generally distributed throughout the British Isles, in localities congenial to Fern life. It is quite evergreen, likes a well aerated compost of leaf-mould and limy lumpy loam. It is very easily raised from the spores, which are borne in long sausage-shaped masses on the back of the fronds, which masses, having a fanciful resemblance to the legs of the centipede (Scolopendra), give the botanical name to the family, which is a particularly small one. The spore heaps, if closely examined, are seen to consist of two parallel lines, each covered at first by a thin skin springing from the outer side of each pair of spore heaps. This discriminates the species from the Asplenia, which has single lines only, though similarly situated otherwise, and superficially very like when the spores are ripe and the thin original covering skin or indusium is hidden by them. The most beautiful forms of the species are the barren plumosums or crispums, of which many examples have been found wild; these are more or less densely frilled, and, thanks to some exceptions to the general rule of barrenness, have yielded some finely-tasselled crosses, though, as a rule, the crest is at the expense of the frill. S. v. undulatum, a tough and simply-waved variety, has yielded numerous beautifully-fimbriated or fringed crispums, and has under culture given some of the most charming varieties we possess, fringed, frilled, and tasselled to boot.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
bimarginatum	Ulverston	Hadwin	A narrow, neat form, with marginal projection on both sides.
bimarginato-multifidum	—	—	Ditto, with multifid crests.
capitatum	Dalton	Stewardson	Dense, large crests.
c. Forster	—	Forster	Ditto (infra lineate).
c. Studdart	Ireland	C. F. Studdart (1880)	,, ,,
c. projectum	—	—	Sagittate, broad, spreading crests.
cervi-cornu	—	Stansfield	Staghorn-like, marginate.
Cliftii	North Wales	Clift	Multifid, leafy, rounded crests.
conglobatum	St. Pierre	H. Bull (1887)	Deeply cut and projecting edges; sagittate.
congregatum	—	Lowe (r.)	Finely ramo-cristate.
constellatum	—	Glave (r.)	Dwarf, ramose, bunch crested.
Coolingii	—	—	Dense, ramose, fronds forming a ball, bulbiferous on edges; very like Kelwayii, Baxterii, and Wardii.
cornutum	—	—	Fronds rounded off, midrib projecting.
coronatum	—	Stansfield	A corymbiferous form.
corymbiferum Druery	Sidford	C. T. Druery (1888)	Dense, moss-like crests.
Cousensii	Devon	J. S. Cousens	Extremely ramose. quite distinct, ultimate divisions rounded and crenate; also bulbiferous.
crispum	—	—	A term applied to the plumose forms of this species; fronds deeply frilled, usually barren.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
crispum adornatum	—	Lowe	Frilled and tasselled.
c. Baldwynii	Chepstow	Baldwyn	Some fronds frilled, some conglomerate; a remarkable wild find.
c. Bowdon	Lake District	Bowdon	A finely frilled form.
c. capitatum	—	Jones	Large, capitate head.
c. Clapham	Yorkshire	T. Smith (1857)	Fimbriate and crested.
c. Cowburnii	Demuil Hill	Cowburn (1885).	Fine, dentate form, fertile, tips multifid.
c. fimbriatum	—	Stansfield (r.)	A most beautiful variation, finely frilled, and edges finely fimbriate; numerous crested and ramose seedlings have been raised. The original parent was undulato-rigidum, a most unlikely source.
c. f. Cropper	—	Cropper (r.)	
c. f. Stansfieldii	—	—	
c. f. cristatum	—	Stansfield	
c. f. grandiceps	—	”	
c. diversifrons	—	Col. Jones (r.) (1874).	A curious but fine form with rippled fronds.
c. Drummondæ	Falmouth	Miss Drummond	A unique Fern; fronds long and narrow, some fimbriate, some plain, with broad, spreading crests; fronds undulate, switchback fashion. The fimbriations are aposporous and yield true progeny, some of which throw only the fimbriate fronds.



Scol. v. crispum cristatum fimbriatum (Stansfieldii).



Scol. v. crispum grande Wills.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
crispum Drummondæ grandiceps	—	H. Bolton (r.)	A presumed offspring of above, with fimbriate and aposporous crests to all fronds.
c. fertile	Grange	Wrigley (1863)	A fertile crispum, cut edges.
c. grande Wills	Dorset	Wills	A splendid wide-fronded form.
c. Grey	—	Grey and others	The type; many finds.
c Kitsonæ	Devon	Miss Kitson	Finely frilled and crested.
c. latum	Barnstaple	Jackson	Very broad, basal lobes separated from rest of frond lamina.
,,	Nettlecombe	Elworthy	
c. majus Moses	Lakes	Moses	Very fine.
c. muricatum	—	E. J. Lowe (r.)	A muricate cross.
c. ornatum	Cumberland	Troughton	Finely frilled and crenate; multifid.
c. Robinson	—	—	A fine bold form of the type.
c. robustum Jones	Shirenewton	Col. Jones	,, ,, ,,
c. Stansfield	Roundstone	Stansfield	Splendid imbricate frills.
c. Stableræ	Lakes	Mrs. Stabler	Long stiped, erect; finely frilled.
crista-galli	North Devon	Moule (1864)	Crests like a cock's comb.
cristatum	—	—	Fronds tasselled; applicable to many finds.
c. Barraud	—	Barraud (1891)	A finely crested form.
c. Millett	North Devon	Millett (1865)	Crests 6 inches wide.
c. viviparum O Kelly	County Clare	O Kelly	Fronds crested and bluntly sagittate; proliferous on surfaces anywhere.
cristulatum	—	Stansfield (1874)	A round, pretty crest; dense.

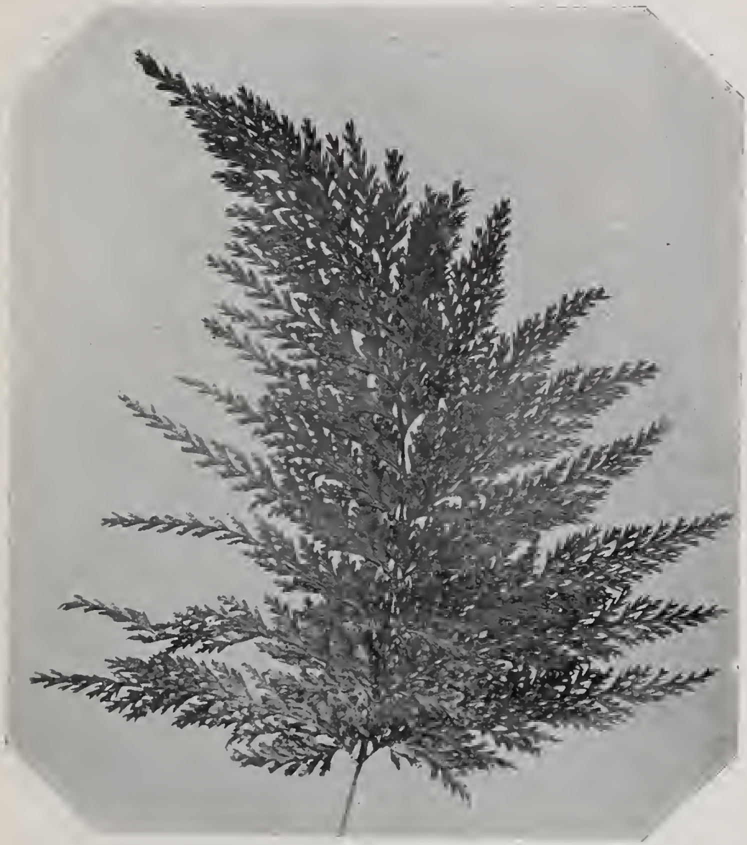
Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
cristulatissimum	—	Birkenhead	More densely crested.
densum Kelwayii	—	Kelway	A dwarf bass of mossy verdure, composed of fine divisions and young bulbil plants.
digitatum	Cork	Crossfield (1860)	Broad, flat crests.
dimorphum	—	Barnes' collection	Two kinds of fronds—one set a good lobatum, the other long and quite linear, with fan-like crests.
Edwardsii	Devon	Edwards	Ramo-cristate.
Fittii	—	—	*See* grandiceps Fitt.
flabellatum	Nettlecombe	Elworthy	Fan-shaped heads.
f. Bolton	Kellet	W. Bolton (1870)	,, ,,
flexuosum	Whitbarrow and elsewhere	Barnes (1861) and others	A curled form.
glomeratum	Jersey	Piquet	A globular, crispy mass.
,,	Storth	Mrs. Nicholson (1867)	,, ,,
grandiceps John Cousins	—	John Cousins	A splendid robust grandiceps.
g. Fitt	—	—	Dwarf, flat-crested.
Kelwayii	Somerset	—	Conglomerate and proliferous; very like Coolingii; parent of densum Kelway.
keratoides	—	Clapham (r.)	Crests like flat stag-horns.
laceratum (endivæfolium)	Somerset	J. Young (1851)	One of the oldest and best; fronds almost pinnatifid, and basal lobes long and crested; varies much, but does not revert.
limbospermo-cristatum	Somerset	Elworthy (1858)	Narrow form, with lace-like crests, serrate edges.
lonchospermum	Lancs.	Preston (1862)	Narrow, strap-shaped, marginal sori.
,,	Baycliffe Lanc.	Hodgson (1870)	
marginatum	Various	Various	Not uncommon; a well-defined ridge near the margin of contracted fronds, above or below, or even both (bi-marginate).
m. tenue	—	Appleby	Laciniate, toothed edges.
marginato-cristatum	Arnside	Barnes (1860)	Marginate and crested.
m. fimbriatum	—	—	Marginate, fimbriate edges.
m. undulatum	Heversham Head	Barnes	Marginate and undulate; dense.
muricatum	Guernsey and elsewhere	James and others	Rough on upper surface, fronds narrowed.
muricato-spirale	—	Lowe	A cross with spirale.
nudicaule capitatum Forster	—	Forster (r.) (1876)	Round, capitate head on bare stalks.
nudistipes cristatum Mapplebeck	—	Mapplebeck (r.) (1871)	Similar, but crests circular.
omnilacerum Lowei	—	Lowe (r.)	A narrow, pinnatifid form, lobes furcate and multifid.
papillosum	—	—	A form of marginatum with rows of long, excurrent points along the midrib.
pectinatum	—	Jones	A marginatum, with comb-like edge.
peraferens	Ireland	Allchin	Same type as excurrens and truncatum in other species; fronds terminate abruptly with a horn and pouch, sometimes in front and sometimes behind.
,,	Ballygarth and elsewhere	Phillips and others	
p. crispissimum	—	Lowe (r.)	A small crispum, pouched and horned.
p. rosetta	—	Lowe (r.)	Rugose, horned and pouch rosette-like.

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
perafero sagittatum	—	C. T. Druery (r.)	Basal lobes pouched as well as tips.
radiosorum (Druery)	—	S. Wollaston	Normal fronds, rounded off with midrib protruding at the arc of the semi-circle, sori radiate, like clock figures.
ramo-cristatum	—	Clapham, Moly, and Forster	Broad, branch crests in contracted ramifications.
r.-c. Moly	South Devon	Moly (1862)	Splendid form, each frond branching into several distinct and finely tasselled ones.
r.-c. (Woll.)	South Devon	Moly (1862)	Another find; distinct, but ramo-cristate.
ramo-cristulatum	—	Stansfield (1886)	A ramose cristulate form.
ramosum	—	—	Branch crested.
ramo-marginatum	—	Clapham (1869)	One of the finest; broad, spreading, fan-like crests of narrow, marginate divisions.
rugosum	—	—	Surface rougher than in muricatum, with rounded excrescence.
sagittatum	—	—	Applied where the basal lobes are lengthened.
sagittato-crispum	Dorset	Colman (1875)	A sagittate, narrow crispum, something like Drummondæ.
,,	Petersfield (Ottery St. Mary)	Wollaston	Sagittate and frilled.
,,	Ireland	Forster (1876)	,, ,,
s. cristatum	Scarborough	Clapham	Sagittate and crested.
,,	—	Hankey (r.)	Ditto; very fine.
,,	Devon	Hillman (1859)	Sagittate and crested.
,,	Dorset	J. Welman (1873)	,, ,,
s. c. Dadds	North Devon	J. Dadds (1869)	Dwarf, lobes developed into fronds, and crested like the central frond.
s. projectum Moly	Dorset	Moly (1862)	All fine; edges deeply cut or rather extended into pinnæ form; lobes, frond, and tips crested; basal lobes long. The last is distinct, being muricate and shorter in growth.
s. p. Sclater	Sligo	Sclater (1860)	
s. p. Smithies	—	Smithies	
s. p. Westropp	County Clare	Westropp	
s. p. Whitwell	Lakes	Whitwell	
scalpturatum	—	—	Surface rougher than in muricatum, and cut more sharply and deeply than rugosum.
spirale	Guernsey and elsewhere	James and others	Dwarf, spirally twisted, and leathery.
s. muricatum, &c.	—	Lowe (r.)	Mr. Lowe has crossed spirale with muricatum, rugosum, &c., and obtained a multitude of forms.
subcornutum	—	—	Sub-terms for cornutum, according to position of horn beneath or above the frond.
supracornutum	—	—	
supralineatum	Ulverston and elsewhere	Hodgson (1875) and others	A neat ridge on each side of midrib on upper surface.
s. cristatum	—	Jones (r.)	A ramo-cristate form; very fine.
transverso-lobatum	Nettlecombe and elsewhere	Elworthy and others	End of frond splits, forming twin crests, transversely crossing each other very prettily.
t. multifidum	Ilfracombe	Dadds	Similar type.
truncato-cornutum	—	Mapplebeck (r.) (1872)	Frond ends rounded, midrib projecting from centre, no pouch.
,,	Lakes	Hodgson and Crossfield	

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
undulato-rigidum	Devon	Edwards	A stiff-growing undulate form, distinguished as the progenitor of the beautiful fimbriate crispums raised first by Messrs. Stansfield.
undulato-supralineatum Jones	—	—	Probably the finest supralineate form.
unguiceps	—	E. F. Fox (r.) (1870)	A narrow, marginate form, with curved, claw-like crests.
variegatum	—	—	There are numerous types with green and yellow variegation, but this seems dependent on soil and situation, and cannot be depended upon as a constant character; hence no list is given.
Veloisii	France	Introduced by Veitch	An erect-growing, round-lobed, well-crested form; interesting as the one imported variety.
Victoriæ	—	Lowe (r.)	A narrow ramo-cristatum.

TRICHOMANES RADICANS AND HYMENOPHYLLUM TUNBRIDGENSE AND UNILATERALE (THE FILMY FERNS).

THE necessary conditions of constant aerial humidity are so rare, even in our favoured island climate, that only three species of Filmy Ferns out of an immense number of existent ones are found in the British Isles, viz., Trichomanes radicans or the Bristle Fern (page 87), and Hymenophyllum tunbridgense and unilaterale, and these only on or in constantly damp and spray-bedewed rocks and caves in secluded mountain glens or ravines. Culture obviously is confined to Wardian cases, bell glasses, or sunken brick pits covered with a frame; but given them and installation in proper soil, no Ferns are more capable of taking care of themselves, or of affording a maximum of satisfaction to the eye which can appreciate the natural feathery delicacy of Fern frondage, enhanced by the translucent verdancy and emerald sheen of this lovely branch of the Fern family. The soil must be a rough compost of sandy peat, liberally bestrewn and intermingled with lumps of porous stone. The creeping rhizome of T. radicans, or the mat-like masses of the other two, should be pegged down upon the surface, and a quantity of the same but finer compost sprinkled over them, almost burying them, this is then washed well down with a drenching of water until they reappear. Thus installed, cover closely with glass, give ample light, but no direct sunshine, and leave them well



TRICHOMANES RADICANS.

alone. Progress at first is slow, but in the course of a season the rhizomes will begin to spread; new fronds will arise here, there, and yonder, and ere long the full loveliness of each species will come to light, the Hymenophyllum forming a dense mossy carpet, while the taller fronds of T. radicans will form an emerald thicket above them. Some growers advocate a daily wetting overhead, but if they be installed in a cool position and kept very close, we advocate only an occasional wetting, and that with perfectly clean rain water, as preferable to frequent drenchings. The fructification of these species is very peculiar, the Hymenophyllums have the spores in urn-shaped receptacles standing on short stalks by themselves on the branches forming the pinnæ, while the Bristle Fern is so named because they are borne upon bristly projections, partly enveloped in cup-like receptacles embedded in the frond edges.

As regards varieties, the Hymenophyllums have done but little, occasionally ramose forms are found, but none, so far as we know, are constant in this respect, and in any case it it makes no practical difference in the appearance of the mass. T. radicans, on the other hand, has been fairly liberal in varietal forms, though a good crested one still remains unfound; the best are :—

Name.	*Where Found or Raised.*	*Finder or Raiser and Date.*	*Description.*
alatum	Ireland	Clapham	Conspicuously winged.
Andrewsii	Glen Caragh	W. Andrews	Fronds narrow and pinnæ distant.
Backhouseii	Wales	Backhouse	Intermediate between Andrewsii and dilatatum.
Cambricum	Wales	Rowbotham	Similar, but more caudate.
crispum	Killarney	Col. A. S. H. Lowe	Crispate and irregularly ramose, very distinct.
densum	—	Stansfield	Dense fronded.
dilatatum	—	Backhouse	A splendid large foliose form.
dissectum	—	Stansfield	Finely cut, beautiful.
proliferum	Killarney	—	Occasionally bears bulbils like asplenium bulbiferum. The writer raised a number from such bulbils, but none have subsequently appeared.

Though literally foreign to our theme, we cannot help suggesting the association of the above with that exquisite yet hardy New Zealand Filmy Fern, Todea superba. A sunken brick pit, red brick for preference, with T. superba a yard across in all its glory in the centre, the Hymenophyllum as a carpet around it and T. radicans climbing up the walls, as it readily does with the aid of its creeping rhizomes, is a frame for a picture which we will not attempt to describe.

THE WOODSIAS (W. ILVENSIS AND W. HYPERBOREA).

THESE species and the following ones we merely mention for completeness sake and for the benefit of species lovers, since they cannot claim any decorative value, and have afforded no sports worthy of attention. The Woodsias are both mountain Ferns, dwelling in the rock chinks at high elevations. They are small and nearly twice divided, with fronds 2 inches or 3 inches high. W. ilvensis is the larger of the two, and has a longer stalk relatively to W. hyperborea, whose pinnæ are shorter. Otherwise there is little difference. Both are deciduous, and may be grown under a bell-glass. They are characterised by very peculiar and pretty indusia, or spore covers, consisting of a number of radiating filaments, which are turned up over the spores. No varieties of either.

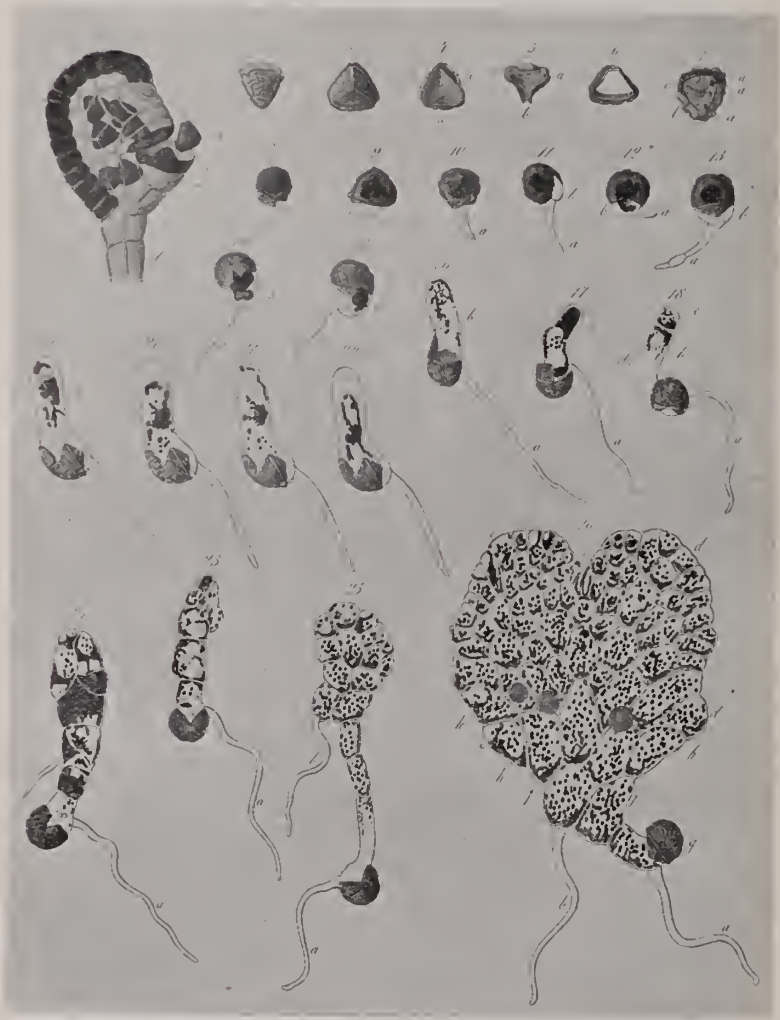
Asplenium Trichomanes var. crenatum growing wild.

A Colony of P. aquilina cristata (Green) at Faygate, Sussex.

APPENDIX.

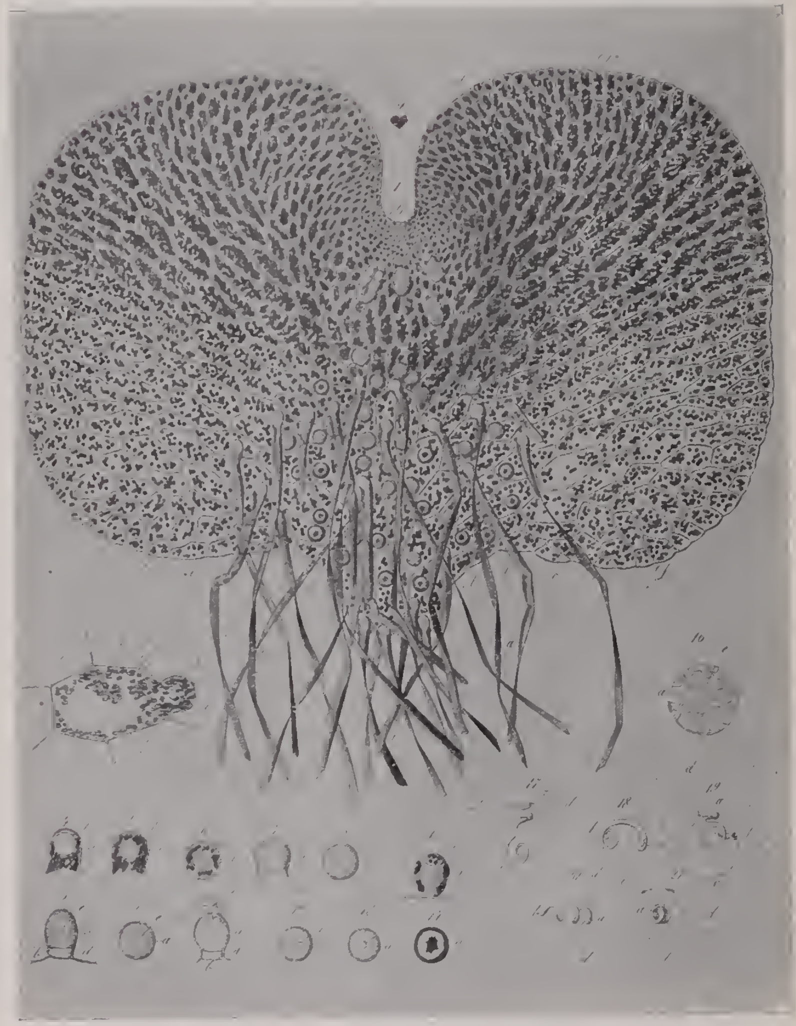
IN the body of this book we have been at some pains to avoid technicalities and the purely scientific side of Fern study. For the benefit of those, however, who may care to dip a little deeper into the life history of Ferns, and for the purpose of bringing the record of elicited facts up to the end of the nineteenth century, we will now give some details of the normal and abnormal modes of reproduction which have been discovered up to the present.

In the first place, then, Ferns differ essentially from flowering plants, in the important respect that no detached seeds are produced, and that the existence of a seed is preluded by that of a spore. The spores, which are found on the backs of, or elsewhere on, the fronds, as already described, are minute bodies consisting of a cell protected by a husk or hard skin, and differ from a seed in the essential fact that they are not the product of a fertilisation, and do not therefore contain the embryo first leaf or leaves conjoined with an embryo root with which a seed proper is furnished. A seed thus constituted has simply to be sown under congenial conditions of warmth and moisture in order to swell, protrude a root, burst its shell, expand its first leaf or leaves, and then become a plant of the parental type. The process is direct and simple. The spore, however, has a roundabout course to pursue to achieve its end, *i.e.*, the production of a spore-bearing Fern like that from which it was shed. To elucidate this process we refer to the series of self-explanatory illustrations herewith given, and especially to that marvellous set which we reproduce from the original drawings of Count Suminski at the time of the first full demonstration of the normal life-history of Ferns, the final link of which he discovered in 1846. From these pictures it will be seen that the first product of the spore is a little row of green cells, which, after forming a tiny club-shaped leaf, stops growing at the apex, and by lateral expansion forms a heart-shaped primary leaf or "prothallus." Upon the under side of this as it develops a large number of root-hairs appear, and scattered among these are a number of small bullet-

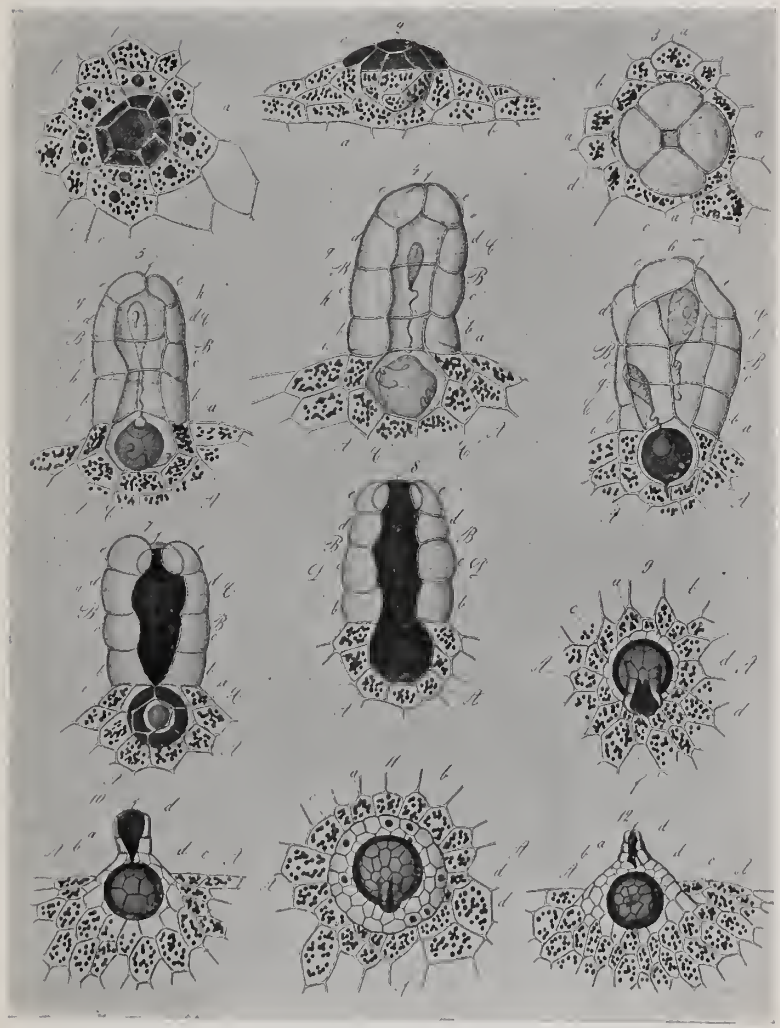


Details of Development of Prothallus from Spore (Suminski).

headed projections (antheridia), while upon a thickened cushion, close to the indentation of the heart, a little cluster of teat-like bodies (archegonia) also appears. At the base of each of the latter, and embedded in the substance of the prothallus, there lies an embryo seed, a single one, but otherwise constituted precisely like the seed in the ovary of a flowering plant. Within the bullet-headed bodies lie closely packed a number of tadpole-like organisms (antherozoids), which, when mature, burst the capsule, and by the aid of cilia or moveable hairs, swim actively about in the dew-like moisture which usually is present on the under side of the prothallus. These are equivalent to the pollen grains of flowering plants, and perform the same office by making their way to the archegonia, or teat-like projections, and fertilising the embryo seeds at their bases. We thus see that the Fern practically bears its flowers on the tiny heart-shaped prothallus, but on such a minute scale that it is small wonder that the process eluded the research of botanists until the above date. The seed once fertilised sends down a root proper into the soil, and a frond proper into the air through the indentation of the heart, the prothallus itself then usually perishing. As a rule only one seed yields a plant, the rest of the cluster aborting. If, however, the prothallus be cut in two with a razor through the cushion, each half is capable of developing independently, and, indeed, experiment has shown that by repeated division a considerable number of Ferns may be produced from a single spore. A glance at our illustrations will make the normal process perfectly clear, since every stage is shown; but Nature sometimes varies it, and since Suminski's discovery of the archegonia and method of fertilisation, which completed this normal life cycle, it has been found that Nature has "rung the changes," so to speak, in every conceivable fashion, cutting out of the life-cycle, in one way or another, every one of the stages without exception. In the first place, Professor Farlow in 1874 found that the prothalli in some Ferns, instead of producing archegonia, or the teat-like bodies aforesaid, with seeds at their base, developed simple vegetative buds or bulbils in their place, and so produced the spore-bearing Fern direct without any sexual agency at all (apogamy). This eliminated both (antheridia with their contained antherozoids) and archegonia from the life cycle. This was followed in 1884 by the writer's discovery of apospory, in which the spore itself is eliminated, the prothallus being produced by direct out-growth from the frond, and then running the normal course. This was eventually found in six species and twelve cases, viz., Athyrium Filix-fœmina (3), Polystichum angulare (4), Lastrea pseudo-mas (2), Scolopendrium vulgare (1), Pteris aquilina (1),



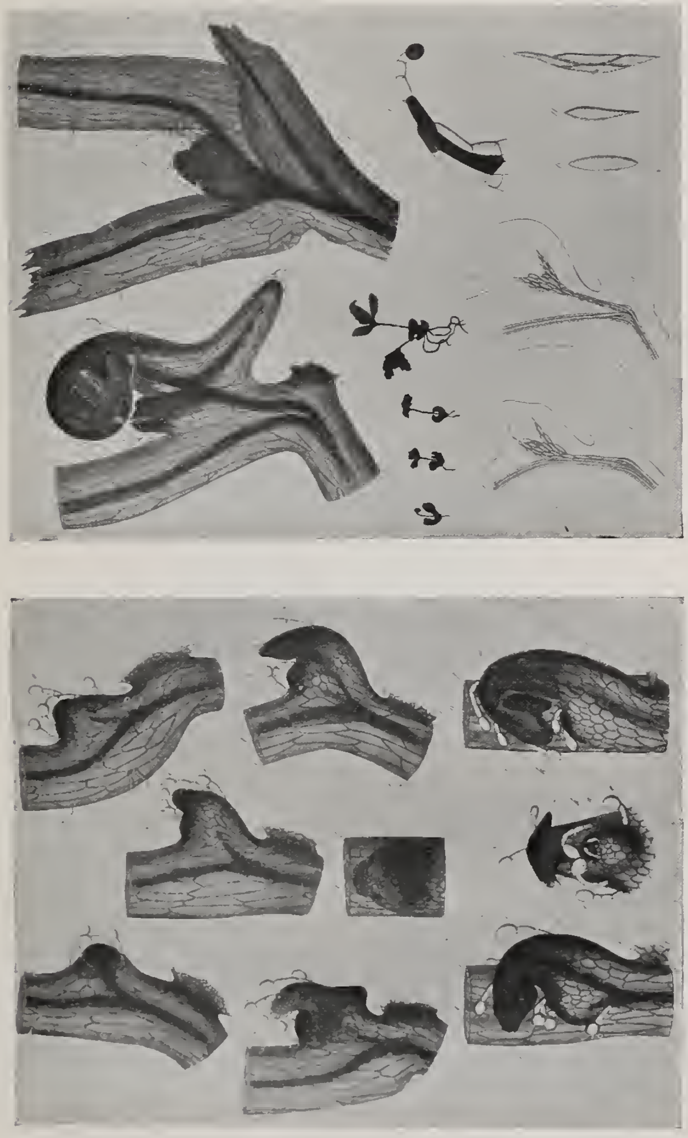
Developed Prothallus, Antheridia and Antherozoids (Suminski).



Development and Fertilisation of Archegonia (Suminski).

Trichomanes alata (1), in some of which, as first pointed out by Mr. G. B. Wollaston, the prothalli spring from the tips of the frond divisions, cutting out the spore heap entirely. Our plates illustrate clearly both these types of apospory, soral and apical, while in one instance noted by the writer the plane surface of the frond broke out into a sort of prothallic rash (panapospory). We have thus got rid of the spore, the antheridia, antherozoids, and archegonia as essential needs, and to get rid of the prothallus itself, we have only to cite those numerous cases where bulbil plants are borne on the fronds themselves, of which we also give a plate. The next step is to get rid of the Fern altogether, *i.e.*, the frond-bearing Fern as we know it, and here Dr. Lang demonstrated the apparently impossible by finding prothalli which bore spore cases (sporangia) and spores which, presuming such spores repeated the process (not yet demonstrated), would reduce the Fern to the lowly Marchantia, or Liverwort type, altogether. We thus see that recapitulating the several phases of Fern existence, spore, prothallus, antheridia, antherozoids, archegonia, fertilised seed, and spore-bearing Fern, each one can be dispensed with. Nature, however, not content with demonstrating this, conjoins her vagaries; thus apospory and apogamy are connected in some cases, so that the fronds are fringed with prothalli, and the prothalli straightway bud back into fronds. These curious prothalli, which bear spores, bear also bud plants, archegonia, antheridia, and other prothalli indiscriminately,

Development of Young Fern (Suminski).



Further Development of Young Fern (Suminski).

as if to show Nature's versatility to the best advantage, so that it is difficult now, if not impossible, to suggest any other modification left open for future discovery, except, perhaps, that so far the germinating spore has always started with a chain of prothallic cells, and might some day see fit to push out a bulbil instead, and so oust the prothallus in a fresh fashion. The lack of any adequate store of nutriment renders this improbable, but when we see roots proper emerging from the surface of a prothallus instead of a bulbil, as in some of Dr. Lang's cultures, it is rash to pronounce anything as impossible, we have only to transform the emerging primary cell into such a self-feeding root, and a subsequent bulbil is easily conceivable; the spore in such a case assuming the function of a seed despite non-fertilisation, just as in apogamy, asexual buds are generated on the prothallus.

For the benefit of those interested, we append reprints of our several Linnean papers bearing on the subject of apospory, and refer them furthermore to Professor Bower and Dr. Lang's monographs and Dr. Stansfield's paper* for fuller details of the other phenomena. For clearness sake we append a list of aposporous Ferns discovered to date, as some of them do not figure in above reports.

APOSPOROUS FERNS.

Name.	*Discoverer.*	*Description.*	*Remarks.*
Athyrium Filix-fœmina clarissima Jones	Druery	Soral	Product, typical.
A. f. f. c. Bolton	Druery	Soral and apical	„ mostly defective.
A. f. f. uncoglomeratum Stansfield.	Stansfield	„ „	„ typical, only induced by long culture.
Polystichum angulare pulcherrimum Padley	Wollaston	„ „	Product, depauperate.
P. a. p. Wills	Druery	„ „	„ „
P. a. p. Mo y	Stansfield	„ „	„ „ rarely true, and then weakly.
P. a. plumosissimum Birkenhead (densely plumose with linguiform tips which develop prothalli with difficulty).	Druery	Apical	Product, typical.
Lastrea pseudo-mas cristata	Druery	Panapospory	„ „ but not aposporous when adult.

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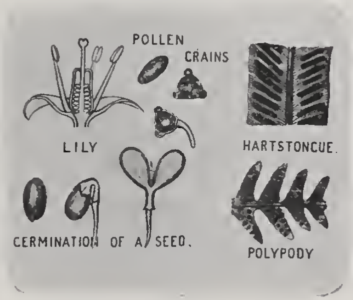
* Professor F. O. Bower, F.L.S., on "Apospory and Allied Phenomena," Linn. Trans., vol. 2, part xiv. July, 1887.

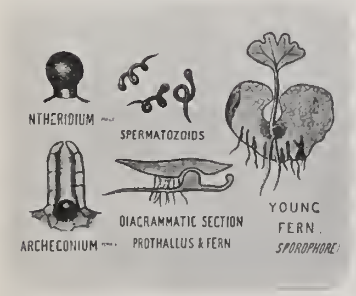
W. H. Lang, M.B., B.Sc., on "Apogamy and the Development of Sporangia upon Fern Prothalli. Phil. Trans. Royal Society, vol. 190 (1898), pp. 187-238.

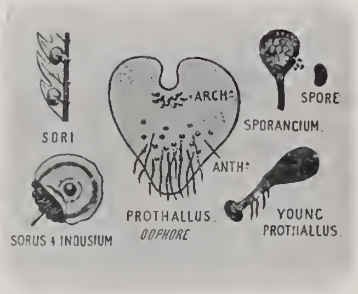
Dr. F. W. Stansfield, on "The Production of Apospory by Environment in A. f. f. uncoglomeratum." Journal Linn. Soc., vol. 34, No. 237. pp. 262-267.

Name.	*Discoverer.*	*Description.*	*Remarks.*
Lastrea pseudo-mas cristata apospora ..	Stansfield ..	Apical	Product, typical.
Scolopendrium vulgare Drummondiæ ..	Druery	,, ...	,, ,, and improved.
Pteris aquilina ..	Farlow	Soral	Found in quantity in U S., otherwise normal.
Trichomanes alatum ..	F. O. Bower ..	Apical	—

In addition to the above, Dr. F. W. Stansfield reports appearance of presumed prothalli on cut and layered edges of Polypodium vulgare grandiceps Parker, culture then failing, and plants in writer's hands of Scol. v. crispum fimbriatum Stansfield (Stansfieldii) are reported by Mr. H. Bolton, of Warton, near Carnforth, to have resulted from layered edges of same variety. It seems probable that any varieties tending to produce filamentous tips or extremely fine divisions might become aposporous under close culture.







APOSPORY IN FERNS.

Appendix. On the Newly-discovered Phenomenon of Apospory in Ferns. [Reprinted, by permission, from the Linnean Society's Journal—Botany, vol. xxi.] Observations on a Singular Mode of Development in the Lady Fern (Athyrium Filix-fœmina). By Charles T. Druery. Communicated by Dr. J. Murie, F.L.S. (Read June 19, 1884.)

THE reproduction of the Filices by their spores results from sexual action taking place upon the under surface of the prothallus to which the spore gives rise. So far, I believe, no development of the perfect prothallus has been observed without the agency of the spore, and the following record of such a case therefore deserves special notice.

Some years ago, a very distinct and beautiful form of Athyrium Filix-fœmina was found wild by Mr. Moule, in North Devon, from whose possession it passed into that of Col. Jones, of Clifton. Many attempts were made at the time to propagate it from what were assumed to be spores, always, however, without success; and at length it was taken for granted that the peculiar growths produced by this Fern in the place of sori were merely abortive spore-cases, and that the plants, like some other abnormal forms, lacked the special vigour necessary for the formation of perfect reproductive spores. All further attempts at raising it were consequently abandoned; and only two divisions of the plant exist.* In the autumn of 1883 I discovered upon another Athyrium (A. f. f., var. plumosum divaricatum), numerous proliferous bulbils, occupying the place of sori on the back of the fronds, and, reporting this to Mr. G. B. Wollaston, he was led to re-examine A. f. f. Clarissima—as the Fern in question had been named by Col. Jones—and came to the conclusion that these so far barren excrescences might be viviparous growths of a kindred nature, and capable of reproducing the parent form by direct bud-development. A portion of a frond was consequently sent to me, and upon examining it under the microscope I found that there were very material structural differences between the unmistakable bulbils of A. f. f. divaricatum and the singular growths upon A. f. f. Clarissima, the former being solitary, bud-like growths, seated in the centre of a number of brown, lanceolate scales, and without a trace of indusium; while the latter were composed of five or six or more flask-shaped bodies, each one larger than the bulbils aforesaid, and seated within an undoubted indusium. The masses were sufficiently large for their formation to be clearly distinguishable by the naked eye, covering more than the space of an ordinary sorus. At this stage no signs of spores or spore-cases could be detected, nor could any axis of growth be perceived; so that it was impossible to form any theory as to the eventual mode of reproduction which might result; for although the tips of the flask-shaped pseudo-bulbils were in some cases elongated into filiform processes, no sign of circination or resemblance to fronds was visible; added to which, the presence of an indusium, in the place of the scales common to true bulbils, led to the assumption that they were abnormal sporoid growths, and not proliferous ones, likely to produce plants by direct bud-growth.

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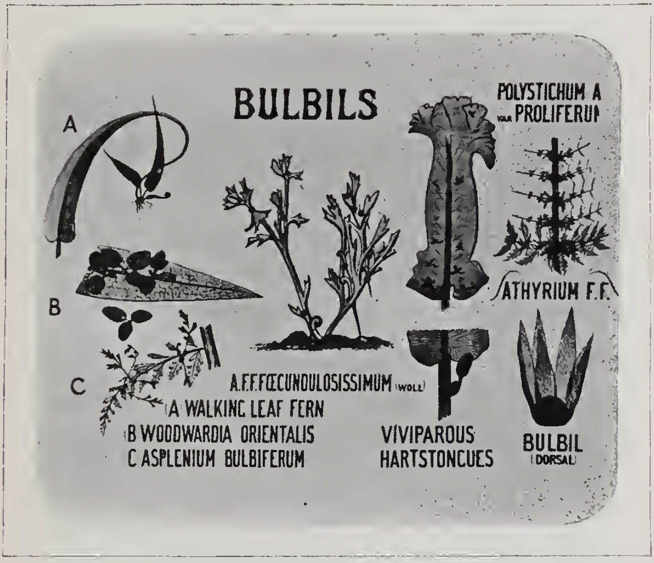
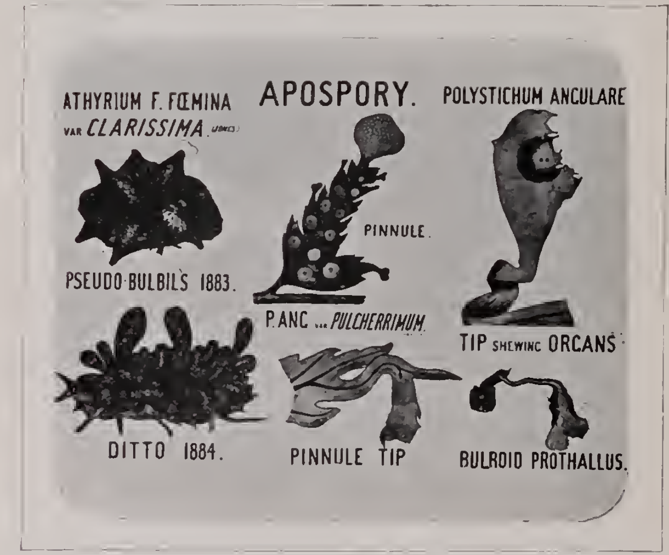
* It is, of course, open to question whether the excrescences formed prior to 1883 were of exactly the same nature. Col. Jones inclines to the belief that they approached more nearly the character of sori, and did not in previous years present the same appearance as now described.



[NOTE.—The above reduced cartoon represents a series of bulbils, the study of which led up to the discovery of apospory, the absence of the scales shown on the last type (Dorsal bulbil), and the presence of an indusium in their stead in the case of A. f. f. Clarissima giving the clue to the prothallic nature which was finally established by culture. The central illustration, by reduction, is shown of the natural size, and represents the first discovery of bulbils on primary fronds.]

To test their capabilities I laid down, on November 27, in a duly prepared seed-pan, numerous pinnæ, which I embedded edgewise, halfway in the soil, the growths being thus brought into immediate contact with it, lying as they did along the rhachides of the pinnæ. I then placed the pan in slight heat, with the result that the pseudo-bulbils immediately began to increase in size, and to develop in such a fashion that on December 24 I was able to record an evident foliaceous extension and division of the tips of the pseudo-bulbils, and the appearance of numerous long, rigid, glassy-looking rods or hairs, which sprang from their bases. These rods bore a strong resemblance to the root-hairs common to the undersides of prothalli; but their decided upward growth, radiating stiffly, seemed opposed to this view, as also the fact that they sprang from the bases and sides of the pseudo-bulbils. It is probable, however, that they acted as aërial roots, for the growth of the tips of the pseudo-bulbils proceeded rapidly, until, on February 10 of the present year, I recorded that they had assumed a decided prothalloid form, while the upright rods had either become deflected or absorbed. Eventually, all the tips of the flask-shaped bulbils assumed the form of perfect prothalli of the usual size and shape, the pseudo-bulbils themselves being absorbed and disappearing, and the



[NOTE.—The two illustrations to the left are considerably magnified, the groups of bulbils were but little larger than the normal spore heaps or sori, the others are enlarged two or three diameters.]

usual root-hairs developing under the prothalli. On March 17 several of these prothalli were examined microscopically, both by myself and by the Rev. Mr. Aubrey, of Salisbury (to whom I am indebted for aid in observing the final stages of growth), and well-developed archegonia were found in the usual place and number, but so far neither of us was able to detect antheridia. Early in May, however, I succeeded in finding a single antheridium; and it is manifest that many others must have been present on the prothalli not examined, as on May 21 the final stage was reached, small fronds being visible in several cases, projecting from the bifurcation of the prothallus, and evidently, therefore, produced from the archegonia by the ordinary sexual mode of reproduction; though the prothalli, as has been shown, had developed from growths that differed widely from spores in their form, their size, persistent adherence to the pinnæ, their production of root-hairs from their surface, and, finally, in the development of the prothallus from their apices by simple extension of growth.

Lest it might be assumed that these prothalli may after all have resulted from true spores scattered amongst the excrescences described, it should be borne in mind—first, that no spores or spore-cases could be distinguished when the pinnæ were laid down; secondly, that all attempts to raise this Fern from spores have failed; and, finally, that the entire development of the prothallus from the pointed tip of the pear-shaped pseudo-bulb—its dilatation, bifurcation, and gradual assumption of the true prothallus form—has been carefully watched and noted step by step, not merely in one case, but in many, in all of which the prothallus was evolved precisely in the same way.

Where, as in this case, the whole phenomenon is new to the observer, many points of interest are apt to be overlooked, their importance being unknown until too late. Another season's growth may therefore confidently be expected to throw more light upon this development, and especially in relation to the first appearance of the pseudo-bulbils themselves, which only came under close observation when already of considerable size.

In framing this account of the occurrence, I have confined myself as strictly as possible to a simple, and I hope clear, record of the phenomena observed during the various stages of growth of the abnormal sporoid excrescences under observation. In conclusion, however, I may be permitted to point out, in connection with such phenomena, that, so far as formal records are concerned, the family of Athyria has hitherto been remarkable for the non-proliferous character of the fronds, which, considering, first, its near relation to the Asplenia, so many of which are profusely proliferous, and, secondly, the protean nature of the family itself, is a singular fact. The discovery, however, of numerous proliferous buds which appeared upon some very small plants which I exhibited here in 1882 led me to institute further enquiries into this subject. I then ascertained that Mr. Mapplebeck had already observed the same phenomenon, and raised plants from similar bulbils, which appeared identical in position and character with those of the Asplenia. Last year, as already remarked, I found another and very distinct form of proliferation on a mature plant of A. f. f. plumosum divaricatum, upon which numerous bulbils were evolved in the place of the sori, this, be it observed, being on the under side of the pinnæ, a most unlikely place for such growths. This same transformation of the reproductive energy had already been observed on three other kindred forms of Athyrium, upon one of which the bulbils and sori were scattered almost indiscriminately over the back of the fronds, some of the sori seeming to be in an intermediate amorphous condition ; though in all other cases, so far as I could see, the sori and bulbils were distinctly differentiated by the presence, in the former case of an indusium, and in the latter of lanceolate scales arranged shuttlecock fashion around the bulbil, no trace of indusium existing. Such bulbils had, until this season, failed invariably to yield plants, and seemed incapable of forming a proper axis of growth. Mr. G. B. Wollaston has, however, succeeded in obtaining plants this spring from A. f. f. plumosum elegans, and one or two of those from A. f. f. plumosum divaricatum have developed fresh fronds with me.

From this it will be seen that no less than three distinct forms of proliferation have now been observed on the Athyria :

1. Bulbils of the ordinary character, developed in the axils and on the superior surface of the pinnæ, and agreeing in character with the ordinary bulbils of the Asplenia.

2. Bulbils formed apparently by transmuted spore-producing energy, and occupying the place of sori, *i.e.*, on the under side of the pinnæ—a position so far, I believe, quite unrecorded in connection with any of the Filices.

3. A new form of proliferation altogether, viz., proliferous prothalli arising from pseudo-bulbils produced by a different transmutation of the reproductive force, and evolving plants only after the prothalli have produced the usual sexual organs common to prothalli resulting from spores.

SINGULAR MODE OF REPRODUCTION IN ATHYRIUM FILIX-FŒMINA VAR. CLARISSIMA.

Further Notes on a Singular Mode of Reproduction in Athyrium Filix-fœmina, var. Clarissima. By Charles T. Druery. Communicated by Dr. J. Murie, F.L.S. (Read November 20, 1884.)

AT a meeting of the Linnean Society in June last I had the honour of bringing before your notice a record of certain phenomena which I had observed during the past winter in connection with the reproduction of a form of Athyrium Filix-fœmina through prothalli, which were not produced from spores, but from certain excrescences evolved in their stead upon the under surface of the pinnæ. The Athyrium in question, which was found wild in Devon, had been for many years reputed barren, the fructification, which appeared copiously, yielding no perfect spores, the result being that after a long period only two plants existed, the original plant having permitted but one division. In 1883, one of these plants, which had been grown under cover, was observed to produce upon the inferior surface of the pinnæ a large number of curious excrescences, consisting of pear-shaped, bulbilloid growths, attached firmly to the frond by their thicker extremities, and seated in every case within indusia, thus occupying the place of sporangia, to which, however, they bore no resemblance whatever. Mr. G. B. Wollaston, whose attention was drawn to them by the previous discovery of bulbils proper upon other Athyria in the same year, which bulbils also occupied the place of sori, was of opinion that they were also bulbils. However, on comparing them with the bulbils produced on these other Athyria, I was struck by the fact that, while in the other cases the bulbils were seated in the centre of scales arranged shuttlecock fashion around them, in this case indusia were present instead, which led me to look upon them as sporoid growths of a character essentially different from the bulbils common to many Ferns. I consequently laid down a number of pinnæ, with the result that I read before you in June, viz., the production of perfect prothalli by the bifurcation of the points of the pear-shaped pseudo-bulbils, which prothalli eventually developed archegonia and antheridia, and finally yielded plants of the same type as the parent.

At the meeting in June I could do no more than lay the consecutive record of my observations before you, since all traces of the preliminary stages had vanished when the young plants appeared, and these were then too diminutive for their character to be determined; they also afforded no evidence whatever that they had originated in other than the usual way, viz., from spores, and I consequently did not exhibit them.

To-night, however, I have pleasure in exhibiting some of the plants produced as I have described. I had hoped, too, to be able to bring pinnæ bearing pseudo-bulbils as described and sketched by me last year ; but owing, partly, I believe, to the long, dry summer, and partly to the fact that the parent plant (which is not under my control) was placed out of doors for a time, I am only able to produce pinnæ showing the fructification in a very immature state—not so immature, however, but that they afford ample evidence of abnormality.

To anyone accustomed to deal with Athyrium Filix-fœmina, the first glance will strike one with surprise at the presence of fresh, green, unripe fructification with, in most cases, unlifted indusia, upon a deciduous Fern in November, months after the time when sporangia proper have ripened and scattered their spores, and when the indusia are usually in a ruinous and fragmentary state. Here and there the indusia on the pinnæ exhibited will be seen to be lifted and to partially disclose a number of curious, club-shaped and occasionally serpentine, cellular masses which, though very different from the swollen, pear-shaped bodies of last year, differ as widely from embryo sori, showing no signs whatever of annulation or of the symmetry which would characterise immature sporangia when sufficiently advanced to protrude from the indusium. While, however, the pear-shaped pseudo-bulbils are conspicuous by their absence, it will be seen that some of the club-shaped excrescences are larger than others. From their general appearance, I believe that, given a more favourable season, some few would assume predominance, and form the pear-shaped pseudo-bulbils at the expense of the weaker growths, which would abort, as in many analogous cases. I incline the more strongly to this opinion, as among the bases of the pear-shaped bodies produced last year there were numerous thin, thready, and shapeless growths, exactly such as would be likely to originate in such a way.

My present object being to confirm as far as possible the data I gave in June, I would call your attention—first, to the existence of the young plants upon the table, raised as described ; and, secondly, to the manifestly non-soriferous form of fructification borne by the parent plant, an examination of which will, I think, go far to convince you that its offspring are engendered neither through spores nor by bulbils, but by some other mode of reproduction—a mode which, from constant and careful watching through all its stages, I believe to be one so far unrecorded in connection with any other Fern—viz., through prothalli produced, not from spores, but by direct bud-growth from the parent frond.

APOSPORY IN FERNS.

On Apospory in Ferns (with special reference to Mr. Charles T. Druery's Observations). By F. O. Bower, M.A., F.L.S. (Extract.) (Read December 18, 1884.)

MR. C. T. DRUERY has already drawn the attention of the Society, in two successive papers, to Athyrium Filix-fœmina, var. Clarissima, ascribing to that plant a mode of transition from the sporophore generation (or Fern-plant), to the oophore (or prothallus), without the intervention of spores. He has pursued the subject with success, as far as it is possible without subjecting the matter to a detailed microscopical investigation. We are indebted to this observer, not only for the communications already received from him, but also for his generosity in supplying to the Royal Gardens at Kew material fitted for the more detailed microscopical analysis of the process. Without further recapitulation of Mr. Druery's results, I may at once proceed briefly to describe the observations which I have made on the cultures now in progress at Kew. Many minute details will be deferred for the present, till the investigation is completed; the chief results are, however, of such importance as to justify a preliminary notice of them.

The sori in Athyrium Filix-fœmina, var. Clarissima, appear in the normal position with a normal indusium. In the condition in which the specimens were when first I received them (November 29), the large majority of the sporangia presented an abnormal appearance. Some few appeared of nearly normal structure, with an annulus, but were arrested at a point of development before the formation of the spores; others, and indeed the majority of them, showed more or less distinctly the central archespore, together with the cells which would normally form the wall of the sporangium; but there the normal development seemed to have been suddenly arrested—the archespore had not in these cases divided further to form either the tapetum or the mother-cells of the spores. The arrest of development of the archespore is, however, compensated in these cases by the more active vegetative development of the stalk of the sporangium and of the superficial cells of the head, the result being that the arrested sporangium ultimately appears as a club-shaped body of larger size than the normal sporangium. The individual cells also are of larger size; they contain numerous chlorophyll granules, which, if present at all in normal sporangia, are relatively few in number. Further, the more rudimentary the head of the sporangium is, the more marked is the vegetative development of the remaining parts.

If pinnules showing the above characters be subjected to favourable conditions of heat and moisture, the vegetative development of the sporangia may proceed at once. On pinnules laid on damp soil, and forced quickly in the propagating-pits at Kew, the earlier stages of this further development have been traced. The details show great irregularity; and they are found to correspond to the greater or less completeness of arrest in the normal development of the sporangium. Thus, sporangia which show a clearly marked annulus do not usually assume any further vegetative activity; those, however, which are arrested at an earlier stage in their normal development may produce, by a purely vegetative process, outgrowths of very irregular form. Sometimes all the superficial cells of the club-shaped body may take part in the process, and this is most clearly seen where the arrest of the normal development is most complete. In other cases the head of the arrested sporangium may be thrown off, while the stalk continues its vegetative growth. The result is in either case the formation of flattened structures, consisting only of parenchymatous, chlorophyll-containing cells, which, sooner or later, show at one or more points on their margins that growth with a wedge-shaped, apical cell, which is well known as characteristic of the Fern prothallus; root-hairs are at the same time formed by the outgrowth of individual cells. None of my cultures have as yet formed sexual organs: this we must wait for; but meanwhile it may be remarked that Mr. Druery's observations during the last two years show that, in the cases observed by him, sexual organs were formed, and young Fern-plants were produced by them. In any case, however, the above observations show that in the Fern in question there is a transition from the sporophore generation to a structure of a prothalloid nature, without the intervention of spores, and that it is formed, by a process of purely vegetative growth, from more or less reduced sporangia. Finally, it may be stated that my observations do not exclude the possibility of a formation of such structures by a vegetative outgrowth of the base of the sorus itself; whether this actually occurs must be decided by further investigation.*

Through Mr. Druery I have Mr. G. B. Wollaston's permission to mention a still more interesting example of apospory, of which the latter gentleman is the discoverer, viz., Polystichum angulare, var. pulcherrimum. Here flattened organs, of undoubted prothalloid nature, are formed by simple vegetative outgrowth of the tips of the pinnules, and without any connection with sori or sporangia. At first the tip of the pinnule merely extends, so as to form a flattened expansion one layer of cells in thickness, and with a very irregular margin; while the whole tip curves downwards, and often forms a spiral coil of one or one and a-half turns, closely covered above by the more expanded portion of the pinnule. In other cases the outgrowth may assume very irregular forms. Ultimately the characteristic marginal growth begins at some point, sometimes terminal, but more frequently lateral. The details of this development have not yet been fully investigated. The result, however, is the formation of a flattened, often heart-shaped, expansion, with a thickened cushion similar in structure to that found in normal prothalli; it bears antheridia and archegonia of normal structure; sometimes, as occurs also in ordinary prothalli, they are found both on the lower and upper surfaces. A point worthy of note is that in those prothalloid structures which are taken directly from living leaves in the normal position, without further cultivation, the antheridia and archegonia have not opened; no doubt this is due to the want of water, which, as is well known, is necessary for this process. I have not yet been able to observe the formation of young Fern-plants on these prothalli; but it may be hoped that from cultures now in progress at Kew and elsewhere further evidence may be obtained on this point.

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* Since the above was written the cultures at Kew have progressed, so that prothalli bearing archegonia and antheridia may be seen, still connected at their bases with the pinnule of the parent plant.—February 11, 1885.

This Polystichum is thus an example of the formation of an expansion of undoubted prothalloid nature, bearing sexual organs by a process of purely vegetative outgrowth from the Fern-plant—that is, there is a transition in this case from the sporophore generation to the oophore by a vegetative growth, and without any connection either with spores or, indeed, with sporangi or sori. It may be regarded as a still more complete example of apospory than that of Athyrium Filix-fœmina, var. Clarissima.

APOSPORY IN POLYSTICHUM ANGULARE, VAR. PULCHERRIMUM, WILLS.

Extracted from the Linnean Society's Journal—Botany, vol. xxii. On a new Instance of Apospory in Polystichum angulare, var. pulcherrimum, Wills. By Charles T. Druery, F.L.S. (Read December 16, 1886.)

In December, 1884, and previously, I brought before the notice of this Society the results of certain investigations into a mode of reproduction in Athyrium Felix-fœmina, var. Clarissima, hitherto unobserved, and to which Professor F. O. Bower gave the name of apospory, the spore being eliminated from the life-cycle of the Fern, the prothalli springing direct from the stalks of aborted sporangia. This discovery in the variety of Athyrium in question was followed by Mr. G. B. Wollaston's discovery of a kindred phenomenon in an abnormal form of Polystichum angulare, var. pulcherrimum, Padley, in which plant, however, it is developed in an altogether different manner, the prothalli being produced in this case by simple extension and dilatation of the growing tips of the pinnules, so that not only the spore, but the entire sorus is excluded from the normal cycle of existence.

The particular specimen of Polystichum angulare, in which this phenomenon was remarked, was found many years previously growing wild in North Devon, since which time it had constantly produced its characteristic expansions of the pinnule-tips, which, however, were regarded at first as a minute form of that cresting common to so many abnormal forms of Ferns, and consequently their true character as prothalli proper remained for a long time unsuspected.

One of the peculiar characteristics of this Fern is a marked elongation of all the lower divisions of the pinnæ, *i.e.*, pinnules, the upper ones retaining nearly or quite their normal outline; and as it was mainly upon these attenuated divisions that the prothalli were formed, the points running out into threads at the ends of which the prothalli appeared, it struck me that as these attenuated pinnæ were not confined to this individual Polystichum, others presenting the same peculiarity might develop the rest of the phenomena under suitable treatment. I consequently applied to Colonel Jones, of Clifton, for whose aid throughout these investigations I cannot too strongly express my thanks, and was duly furnished with a young plant, of the form known as P. angulare var. pulcherrimum, Wills, found by the late Dr. Wills, in Dorsetshire, some years ago. This form, which, it will be noted, was found some seventy or eighty miles distant from

Mr. Padley's station, moreover differs markedly in general character, so that no doubt can reasonably be entertained of its distinct origin ; the characteristic prothalloid extensions had also never been remarked upon it.

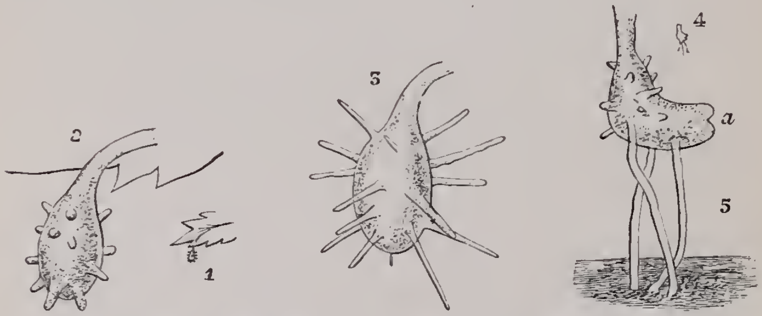
On receipt of the plant early in the present year (1886), I at once placed it in a closed Todea frame, with the result that as soon as the fronds attained the length of some six inches or so I was delighted to find the tips of the pinnules running out and dilating into prothalli in profusion, until the pinnæ were absolutely fringed with them, precisely in the same manner as in Padley's form. Later in the season, however, the close treatment disagreed with the plant, and on removal from the frame to a cool fernery the prothalli dried up and perished ; fortunately, however, not before Professor Bower was able to inspect the plant and obtain material for further investigation. It seems highly probable, from the rapid disappearance of the prothalli, in this case under nearly normal conditions, that they would not be developed under ordinary circumstances to an extent likely to attract observation.

So far, the phenomena observed had been precisely similar to those noticed in Padley's form ; but upon further close examination of the fronds I was struck by the existence of several hydraform bodies, clearly visible to the naked eye, which appeared to be attached to the upper surface of the pinnules well within the margin, and in this respect, as well as in their shape, entirely different from the prothalliform point-extensions.

On examining several of these under the microscope, I found their distinct character emphasised by the fact that they were in every case produced at the ends of excurrent veinlets protruding from the surface of the pinnules, well within the margin, and thickening at the distance of about one-twentieth of an inch into a pear-shaped body, from which radiated in all directions numerous root-like hairs. The brown and shrivelled condition of these bodies led me to the belief that it was essential to their full development, whatever that might be, that they should at an early stage find some suitable nidus whence the hairs, assuming them to be root-hairs, might obtain the needful elements for growth. After a long search I was fortunate enough to find one of these bodies in a young state, the pear-shaped head only being formed, and the hairs just beginning to develop. I at once removed the plant into a large shallow pan and pegged down the frond so that the excrescence was brought into very close proximity to the soil.

This was on September 5, when it presented the appearance shown in figs. 1 and 2. On September 10 I observed that the root-hairs had much developed, radiating stiffly in all directions without any apparent bias towards the soil (fig. 3).

On October 2, after a temporary absence, I found that some water had been spilt over the object under examination, partly burying it in soil; on removing which I found that it had sent several long threads from the lower end into the soil, and that the upper ones had either aborted or been broken off, as nothing but short projections remained. At this date the shape had materially altered in the prothallus direction, having flattened out laterally in the same plane as the soil, and formed an incipient but unmistakable sinus (figs. 4 and 5). Since that date growth has continued, though slowly, with the result that it is now an undoubted prothallus, though much thicker in substance than those produced by extension of the pinnule-tips.



Aposporous excrescence in P. ang. pulcherrimum Wills.

From these observations it will be seen that the formation of the prothallus in this case is preceded by a very different series of phenomena from those already recorded. In the one case the prothalli are simple extensions of the cellular substance of the tips of the pinnules, commencing at points quite beyond the venation, and, so far as I have observed, produce no root-hairs unless brought into contact with the soil. In the other case, however, the prothallus is a direct outgrowth of the tip of a veinlet protruded through the upper surface of the pinnule, and at once produces root-hairs in abundance long before it assumes any other characteristic of a prothallus; and, finally, the resulting prothallus is much thicker in substance. Whether archegonia or antheridia are present upon the solitary specimen I have had under examination I cannot say, as the disturbance necessary for microscopic scrutiny would probably have been more destructive than profitable.

These excrescences, it will be observed, bear several striking resemblances to the pear-shaped pseudo-bulbils first observed in Athyrium Filix-fœmina, var. Clarissima. Their size, shape, and the production at an early stage of radiating root-hairs are peculiarly akin, as also the dilatation of the free end of the body into a prothallus; on the other hand, they are differentiated by their isolation and independent position with regard to the sorus.

I will conclude my remarks by pointing out that in all three cases of apospory now observed there appears correlated with the phenomenon a marked elongation of the ultimate divisions of the frond. Athyrium Filix-fœmina, var. Clarissima, is very remarkable for this character; and on the two species of Polystichum the lower pinnæ are so characterised, while the upper pinnæ, which nearly approach the normal form, are comparatively barren of prothalli. I mention this as it may form a clue to the discovery of the phenomenon in other Ferns which, like the one under special notice, may only require close treatment to yield similar results. I am therefore sanguine that other workers, in not only British, but exotic Ferns, may thus light upon new instances of the phenomenon in question, and so increase the opportunities of completely studying it.

A. F. F. PLUMOSUM DRUERY (YOUNG FROND).

APOSPOROUS LASTREA (NEPHRODIUM).

Extracted from the Linnean Society's Journal — Botany, vol. xxix. Notes upon an Aposporous Lastrea (Nephrodium). By C. T. Druery, F.L.S. (Read November 3, 1892.) (Plate xxxiv.)

THE term apospory has been applied to two abnormal modes of reproduction discovered within the last few years upon certain varietal forms of Athyrium Filix-fœmina and Polystichum angulare, and subsequently upon some exotic specie. In the Athyrium (A. Filix-fœmina, var. Clarissima) the usual sites of the sori are occupied by clusters of cellular excrescences furnished with an indusium, and formed by abnormal development of the sporangia. These excrescences, by expansion of their tips, grow out into normal prothalli, which produce plants of the approximate parental type when pegged down upon the surface of suitable soil. The spore is thus eliminated from the life-cycle. I exhibit a panful of pinnæ showing the early stages of development of the prothalli. In the case of the Polystichums, of which several examples exist, all of similar type (*i.e.*, P. angulare, var. pulcherrimum), though found as solitary sports in widely separated localities, a similar type of soral apospory is found upon some of them; but they are further characterised by prothalli being also formed independently altogether of the sorus by simple extension of growth of the apices of the ultimate divisions of the fronds, or more rarely upon extruded venules near their extremities. These prothalli, however, can scarcely be considered as normal, being very eccentric in shape; and though archegonia and antheridia are produced, and plants have been raised by their interaction, these differ widely from the parental type, are weakly in constitution, and irregular in growth or form. The plants which I have raised from the soral outgrowths of P. angulare, var. pulcherrimum, Moly, are also defective and lacking in vigour. This, however, is not the case with the Athyrium, the aposporous offspring of which are robust and fairly typical. It was my good fortune to discover soral apospory in Athyrium Filix-fœmina, var. Clarissima, and Mr. G. B. Wollaston followed with the discovery of apical apospory in Polystichum angulare, var. pulcherrimum, Padley; and in the latter it will be seen that the life-cycle is still more shortened by the elision of not merely the spore, but of the sporangium and entire soral apparatus.

So far the phenomenon has only been remarked on adult plants, and the case, therefore, to which my present notes relate is new to the extent (1) that not merely apical, but a sort of panapospory has developed itself; (2) that this has appeared upon a young Fern seedling only just emerged from the prothallus; and, finally (3), that the Fern is a Lastrea or Nephrodium, and therefore a distinct species from those already recorded as aposporous.

On July 17, while seeking for bulbils upon a proliferous form of Trichomanes radicans kept in a close Wardian case, my attention was attracted by what I at first took for a prothallus developed by a deposited spore upon the tip of a seedling Fern frond near the edge of the pot, a not impossible occurrence, as spores frequently germinate and attain the prothallus stage upon the fronds of Todeas and other Filmy Ferns under very close conditions of culture. The size of the prothallus, however, which was nearly fully grown, coupled with the extreme youth of the frond which bore it, led to a closer examination; and then I found that it was an actual outgrowth of the frond itself, and that, furthermore, it possessed a feature I had never observed in apical prothalli before when attached to the frond and not pegged down, viz., an abundant crop of root-hairs behind it. These, presumably for a lack of a suitable nidus, were brown and partly shrivelled, but the prothallus itself was perfectly green and healthy, and clear indications of an incipient cushion were visible near the sinus by transmitted light. Antheridia were also sparsely visible, but no archegonia. On further examination, I perceived that besides this terminal prothallus a number of rudimentary ones were projecting from the lateral edges of the pinnæ, some of them bearing numerous root-hairs, while a bunch of root-hairs had also been developed behind the tip of one of the pinnæ upon an irregular prothallic outgrowth. The frond upon which this aposporous development appeared was about three-quarters of an inch high, including the long stipes attaching it to the prothallus upon which it was engendered. A later frond had formed a similar stipes, and was just commencing to uncoil; this, however, was in too incipient a state to show any trace of prothallic outgrowth. At the base the stump of a third stipes was visible, presumably that of the primary frond thrown up by the prothallus, that bearing the secondary prothalli being distinctly pinnate, which is rarely the case with first fronds.

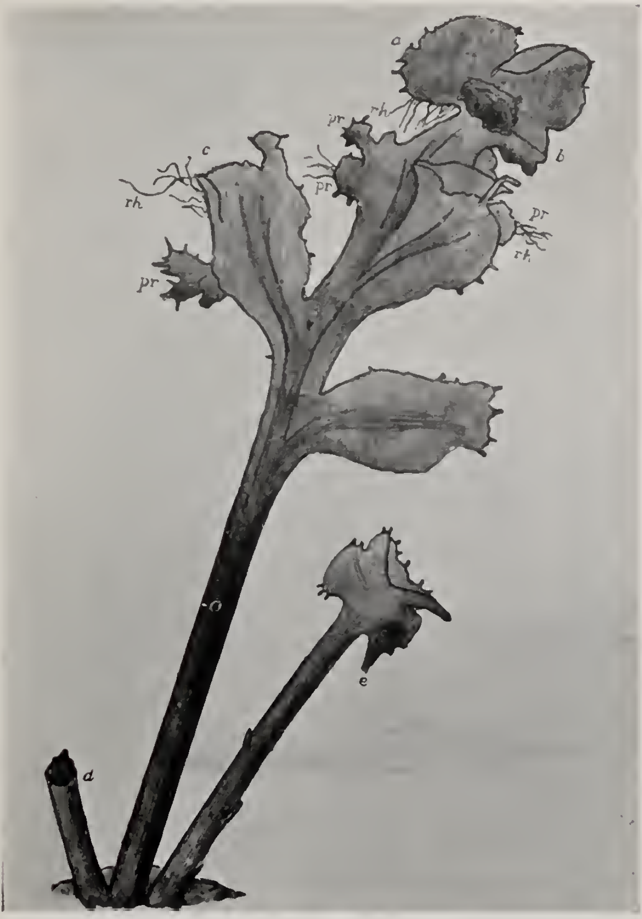
Owing to the absence of the primary frond and the altogether abnormal character imparted to the second one by its outgrowths, I was unable at the time of making the sketch which I exhibit to determine its species. In this sketch, which enlarges the plant considerably, the condition of the second frond is given as it appeared in July. Shortly afterwards, as it began to show signs of decay, I placed a small piece of loam behind it to stimulate the prothallic growth, the result of which has been a partial resuscitation accompanied by a splitting up of the terminal prothallus into several smaller ones, but no definite progress in the direction of reproduction.

Meanwhile, however, the next frond in succession grew on, and at first showed no signs whatever of prothallic buds, perfecting, indeed, its normal growth entirely without a sign of them; this completed, however, an irregularity appeared at the top of one of the basal pinnæ, and very speedily others appeared at all points and edges generally, root-hairs and prothalli being developed simultaneously. At this stage, too, the flat surface of the frond along the line of the rhachis broke out into an eruption of small pimples, which very speedily assumed the perfect normal form and size of prothalli; so that at the time of writing (October 23, 1892) the upper part of the frond is completely covered by a bunch of prothalli of various sizes, all arising by simple budding and extension of the cellular growth of the frond itself.

At present the next frond in succession presents no abnor mality save a terminal expansion and furcation of the rhachis, which, in conjunction with other specific characters now clear enough, proclaim the plant to be a tasselled form of Lastrea, presumably the old L. Pseudo-mas, var. cristata; and this leads me to surmise that apospory in this instance is connected with, and possibly the outcome of, apogamy.

Professor Farlow, when he discovered that phenomenon, found that Lastrea Pseudo-mas, var. cristata, was constantly apogamous, *i.e.*, was constantly produced from the prothallus by simple bud-growth without the sexual interaction of the antheridia and archegonia. That, it will be seen, is precisely the converse of this case, where the sporophore buds out directly into the oophore. Now, assuming such an origin for the plant under notice, it seems to me not at all surprising that, being thus produced by simple bud-growth from a prothallus, it should be to a certain extent unstable, and apt, if grown under specially close and relaxing conditions of culture, as in this case, to revert to the prothallic cell-formation from which it has so recently deviated in an abnormal manner and minus that vital line of demarcation between oophore and sporophore which normally is drawn by the action of the antherozoids upon the archegonial bud.

Upon close examination of the plant which I exhibit, it will be seen not to be alone, a smaller one, exhibiting the same characters in a minor degree, being associated with it. The original prothallus having decayed, I am unable to determine whether both these plants are derived from it; if so, they are sufficiently far apart to point to an apogamous origin, since twin plants normally produced are usually closely attached to each other. According to Professor Bower* apogamy and apospory undoubtedly occur simultaneously in Trichomanes alatum. Finally, I may add that the Fern before you has not been in any way stimulated by abnormal warmth, but developed its peculiarities in a close but cold Wardian case.



Young frond of Lastrea Pseudo-mas, var. cristata, bearing aposporous prothalli. (Natural size ¾ inch.)

a. Terminal prothallus, with profuse root-hairs at back; *b*. Incipient cushion; *c*. Pinna-tip bearing root-hairs, without any defined prothallus; *pr*. Marginal prothalli; *rh*. Root-hairs; *d*. Stump of primary frond, apparently eaten off; *e*. Third frond unfolding.

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* "Annals of Botany," vol. i., p. 300, pl. xvi., fig. 35, &c.

APOSPORY.

Extract from the Linnean Society's Journal—Botany, vol. xxx. Notes upon Apospory in a Form of Scolopendrium vulgare, var. crispum, and a new Aposporous Athyrium; also an additional phase of Aposporous Development in Lastrea pseudo-mas, var. cristata. By Charles T. Druery, F.L.S. (Read December 7, 1893.) (Plate xvii.)

THE case of apospory which I have the honour of bringing before the Society this evening is an entirely new one, in so far as it is exhibited by a fresh and apparently most unlikely species, viz., Scolopendrium vulgare, the normal smooth-edged strap-shaped fronds of which seem to offer no outlet for apical apospory, displaying, as they do, not the slightest tendency towards the formation of the slender lateral projections with which the phenomenon is usually associated in its apical form.

It was on a special visit to Mr. T. Bolton, of Warton, near Carnforth, in August last, to inspect a new aposporous Athyrium, to which I will later refer, that I came across the case now under notice in the shape of a variety of Scolopendrium vulgare, known as Scolopendrium var. crispum Drummondæ, found many years ago by Miss Drummond near Falmouth. This is a very singular compound variety, in which the fronds are very long and narrow, finely frilled, and bearing, in addition, broad flat digitate crests, often nine inches across. Another peculiar feature is that the midrib is deeply undulated several times perpendicularly to the plane of the frond, and finally the margins of the frills are deeply cut into long fimbriate projections.

Mr. Bolton kindly sent me a plant, and on its receipt I at once perceived that in many cases the apices of these projections were bifid and translucent, presenting all the features of incipient prothalli. I consequently cut off a number of these with a small portion of attached frond, and inserted them in sterilised soil so that the terminal points, or bifurcations, were in contact therewith. In a few days evident signs of growth were visible, and in a week or two distinct prothalli of more or less cordate form, and of normal size, were developed, twin prothalli resulting in some cases, each limb of the bifurcations having developed independently. Root-hairs, however, were very tardy in appearing, due probably to the fact that growth was sustained by absorption through the adherent portions of frond; later on, however, they appeared somewhat abundantly, though hardly in normal quantity. In some cases, thick fleshy prothalli of irregular form were developed from quite blunt projections, which, when laid down, showed no signs whatever of prothallic growth.

In October I sent several specimens of these prothalli to Professor F. O. Bower, at Glasgow, and upon one of these he found numerous archegonia, both old and new, but no antheridia. The fact of these being true prothalli was, however, thus fully established. Later, in November, I found both antheridia and archegonia in abundance on one of the largest prothalli in my culture, an abnormal feature of which was the production of these organs in quantity on both upper and under surfaces in conjunction with root-hairs, which, however, predominated on the lower surface, as might have been expected. It remains, of course, an open question whether plants will be produced; but, from general robustness of growth, I have little doubt on this point.

I exhibit the plant under notice, upon which the fimbriate projections will be clearly seen, though, unless laid down as described, they have failed to develop more than quite incipient prothalli even in a close warm frame. I also exhibit the cultures, two in number, showing developed prothalli, and accompany my notes with a sketch of a portion of frond, natural size, and enlarged drawings of material after culture.

This constitutes the fourth British species in which apospory has been shown to occur, viz., Athyrium Filix-fœmina var. Clarissima, Polystichum angulare var. pulcherrimum (several forms) Lastrea pseudo-mas var. cristata, and Scolopendrium vulgare var. crispum Drummondæ.

The second exhibit consists of cultures of a new aposporous find of Athyrium Filix-fœmina by Mr. T. Bolton, who showed some pinnæ at the meeting of the British Pteridological Society at Lancaster in August last. This had been found in the autumn of 1892 in that district, and on examining the portions of frond submitted I was at once struck with its strong resemblance to that form of Athyrium Filix-fœmina upon which apospory was first discovered, and was found in North Devon. The peculiar slenderness and attenuation of all subdivisions and the general make of the two Ferns were almost identical, though the second find is easily recognisable by most of the terminals being spiral. When the pinnæ were handed to me they were accompanied by the remark that "the spores never seemed to ripen;" and upon turning them over, the reason was obvious, since I immediately recognised the peculiarly woolly appearance of the sori, indicative of apospory, the masses of incipient prothalli being in this case so large as to give in some places a suprasoriferous appearance to the frond. As Mr. Bolton very kindly provided me with material, I laid down several pinnæ with the excrescences next the soil, and under close culture actual development immediately began, so that in a week or two each sorus had produced a crowd of full-sized prothalli. Reporting progress to Dr. F. W. Stansfield, who had also received material, he wrote that in his case apical apospory was also appearing, *i.e.*, prothalli were being developed from the apices independently of the sori. Examining my material, I found several apparent cases of this, which, however, on closer investigation I found to be produced from small aborted sori situated so near the terminal point that the resulting prothalli seemed to spring therefrom. I therefore asked Dr. Stansfield to re-examine his material, with the result that in the majority of cases he found the appearance had been deceptive, but in some the apices themselves were certainly dilating. A little later I found an unmistakable instance of an apical prothallus, as can be seen by the culture I exhibit. Otherwise this case is identical with that of Athyrium Filix-fœmina, var. Clarissima, Jones, except that the growths are much more redundant. I have named the Fern therefore Athyrium Filix-fœmina, var. Clarissima, Bolton.

It will be observed that in this case, as in all previous ones, the abnormality occurs on wild finds, and has not been induced by culture, and considering the ease with which the prothalli are produced when the pinnæ are brought into contact with the soil, and the immense advantage which they must derive from being firmly attached to the frond from the beginning instead of, as in the detached spore, being at the mercy of a thousand and one disturbing factors, it is curious that the specimens found are solitary crowns instead of clumps. This advantage, however, in the struggle for existence is far more than counterbalanced by the absence of scattering spores, which limits the variety strictly to its birthplace.

Finally, I exhibit young plants raised from the aposporous prothalli of Lastrea pseudo-mas, var. cristata, which I brought to the notice of this Society in November, 1892. These are interesting as exemplifying exactly intermediate stages between the oophore and sporophore, the primary fronds in some cases consisting of erect prothalli borne on stalks, while in the case of the parent the primary frond had been eaten off when the plant came under notice owing to a prothallus forming at the tip of the second frond, and others subsequently on its edges and surface. This exhibit was therefore necessary to complete the case by supplying the missing step, which it does, I think, very satisfactorily.

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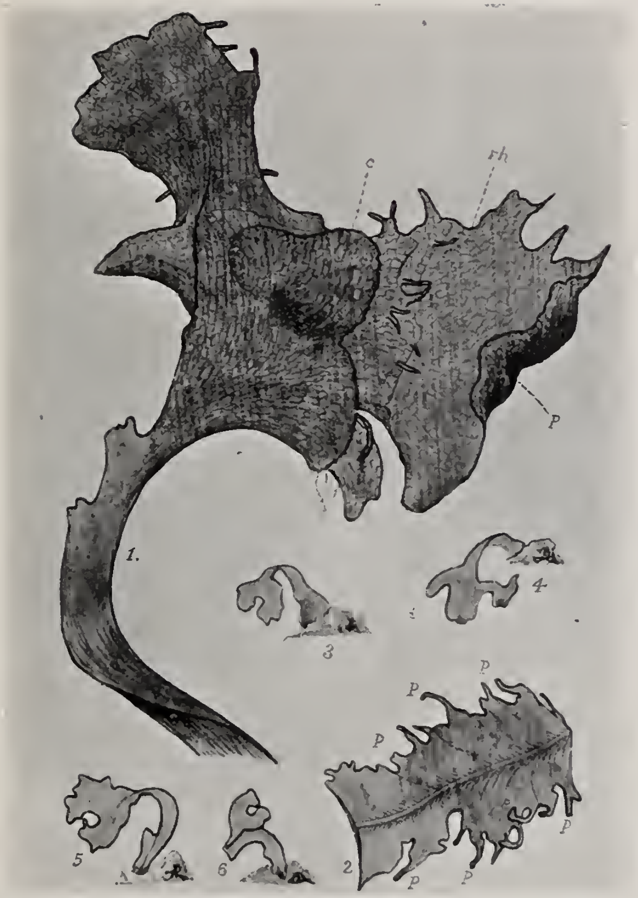

Scolopendrium vulgare, var. Drummondæ.

Fig. 1. Fimbriate projection from edge of frond (much enlarged). *p.* Prothallus developed by culture on moist soil. *rh.* Root-hairs. *c.* Thick fleshy cushion.
Fig. 2. Portion of frond, natural size, showing fimbriate projections terminating in *pp* incipient prothalli.
Figs. 3, 4, 5, 6. Prothalli (× 4) developed after severance of fimbriate projections from frond and insertion in soil.

WEISMANN'S THEORY OF HEREDITY, AND ITS RELATION TO BRITISH FERNS.

BY DR. F. W. STANSFIELD.*

H. SPENCER defines heredity as the capacity of every plant and animal to produce other individuals of a like kind. We are so accustomed to this phenomenon of heredity that the superficial, who always form the vast majority of mankind, look upon it as a matter of course and as a thing not requiring to be explained. The more thoughtful, on the other hand, have for long looked upon it as an inscrutable mystery—a thing not to be explained by human intelligence. Of late years, however, various attempts have been made to penetrate someway into the mystery, and of these one of the most important is that of the German Professor, Weismann.

To put the problem in a concrete and familiar form, we want to know how it is that Ferns always produce Ferns; mice always reproduce mice, and men and women have human children. How it is that seedlings from a Scolopendrium are always Scolopendriums; that in a pure bred herd of Alderney cattle we never get a Kerry calf; that from a pure flock of, say, Black Spanish poultry, we never get a Cochin China chicken. Again, we want to know why Alderney calves are not all alike, but, on the contrary, are all different; why there are so many different seedlings in a sowing of A. f. f. setigerum, and so few variations in a sowing of L. ps. mas crispa gracilis; why the same pair of human parents will have one child with red hair and another with black. Further, we want to know why children (animal and vegetable) occasionally bear a much closer resemblance to one or other of their grand-parents, or even to some more remote ancestor, than they do to their immediate parents.

All these questions and many others Weismann tackles and answers more or less successfully. Of course in the time at my disposal I can only give you a very brief and general outline of Weismann's theory, and cannot pretend to do more than mention the mass of accumulated facts and the chain of reasoning which he adduces in support of his ideas. Those who care to go into the matter more fully will find what they want in Weismann's book, "The Germ Plasm," which has been translated into English and published in the Contemporary Science Series by Walter Scott; price, I think, 5s.

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* Paper read at the meeting of the British Pteridological Society, August, 1896.

Of course the best-known method of reproduction of organisms is sexual reproduction—that is, by the union of two germs; but I need not tell you who are familiar with such things as buds, bulbils, and cuttings that there are asexual modes of reproduction.

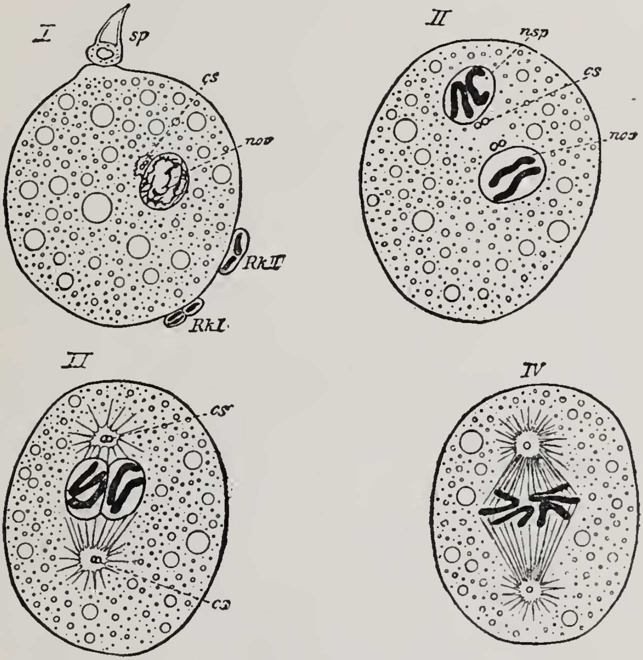

Diagram of the fertilisation of the egg in *Ascaris megalocephala*.—(Compounded from the figures and descriptions of Boveri and others.)

I.—The sperm-cell (*sp*) is about to enter the ovum, which contains a nucleus (*nov*) and centrosome (*cs*). *Rk I* and *Rk II*—the two primary polar-bodies, the first of which has divided into two; each contains two idants.

II.—The sperm-nucleus (*nsp*) has passed into the egg, near the nucleus of which it is situated. Each of these nuclei contains two idants, and also a centrosome, which has divided into two.

III.—The two nuclei are now close together: the centrosomes, with their 'spheres of attraction,' are connected together in pairs, and are situated at the poles of the spindle, which is already visible.

IV.—The nuclear membrane has disappeared, and the first embryonic nuclear division is now taking place.

Of these, in the animal kingdom, I may mention the parthenogenetic production of drone eggs by the queen bee, and the viviparous reproduction of aphides, or green fly, by the imperfect insect, both of which are quite independent of any process of fertilisation. You will not be astonished, therefore, if I tell you that there was reproduction of life upon the earth long before either male or female existed.

To begin, however, with the more familiar process of sexual generation, we know that the whole of the characters of the plant or animal must in some way be capable of being packed up within the extremely minute compass of a sperm cell and a germ cell, and since a spore is capable of producing both sperm cells and germ cells, the whole of the complex characters of a Fern, say Athyrium Clarissima or Lastrea montana Barnesii, must somehow be contained within the narrow compass of a spore.

The ultimate male and female elements are, of course, the ovum or egg cell and the antherozoid or sperm cell. Of these the egg cell is very much the larger, but we do not therefore find that the offspring as a rule resemble the female parent much more than the male. On the other hand, the characters of the two parents are generally fairly equally balanced, and when they are unequal those of the male are just about as likely to preponderate as those of the female.

The inference must be either that the hereditary substance is weaker in the large egg cell than in the very small sperm cell, or that only a small part of the egg cell consists of hereditary substance, the rest being merely nutritive material. There is abundant evidence that the latter is the case. When the sperm cell or antherozoid penetrates the egg cell, it takes no notice of the great body of the latter, but plunges through it and makes straight for the nucleus, with which it blends itself. We shall see by-and-by that there is reason to suppose—not that the hereditary substance is the nucleus or the cell, but that the nucleus contains the hereditary substance.

In order to make myself clear to all, I must go back some little way, and if I describe things which to some of you seem elementary, I trust that you will grant me your patience.

You are all aware that every living organism—whether plant or animal—is built up of cells. Some of the simplest kinds, such as the Amœba and Paramæcium, consist of one cell only, while the great majority of kinds consist of a vast number of cells, which are all formed by the division and sub-division of one original cell, which is again formed, as I have stated, by the union of the male and female germs. The growth of plants and animals consists in the division and sub-division of cells. Within a comparatively few years, it has been observed that whenever a cell divides into two, a very complicated process is gone through. In order to make you understand this, I must describe somewhat minutely the anatomy of a cell. A cell consists of a small quantity of a jelly-like substance called protoplasm, which is enclosed in an extremely thin and delicate membrane.

Somewhere in the interior of the cell, and generally about the middle, can be seen by the microscope a small round spot, generally of a slightly darker colour than the rest of the cell—this is the nucleus. When the nucleus is examined with the highest magnifying powers, it is found to be an extremely complex body; it is separated off from the rest of the cell by an extremely delicate membrane or wall, which, however, under certain circumstances, sometimes disappears. It is permeated by an extremely fine and complicated network of threads. When a cell is about to divide, some curious changes take place in the nucleus, and particularly in the network of threads which I have mentioned. The threads cease to be a network, and assume the form of a single coiled fibre; next, this breaks up into a number of detached pieces, which then arrange themselves in the form of a series of loops around the equator of the cell. Each of these loops then split along its whole length as if a piece of untwisted rope had its strands separated into two thinner ropes, and the split portions are drawn gradually towards the two ends of the cell, where they join themselves together into two bundles, are followed by the rest of the nuclear substance, and form two separate nuclei. While this process has been going on the protoplasm of the cell has been tending to collect itself around the two daughter nuclei, and by the time the nucleus has fully divided, the rest of the protoplasm is ready to follow its example and to divide into two parts. This complicated process takes place whenever a cell divides; that is to say, it is taking place in millions of cells in almost every growing plant. To it the name of mitosis has been given by biologists, and it is highly suggestive of the extreme importance of the nuclear threads of which I have spoken, and to which the name of chromosomes has been given, because they have the property, in a pronounced degree, of absorbing colouring matter, which may be brought in contact with the cell to which they belong. Now an egg cell is developed from the ovary in the same way that other cells are developed. When, however, an egg cell is fully developed or ripe, its nucleus divides into two parts, but, instead of the whole cell dividing, one of the halves of the nucleus is simply thrust outside the cell, and there perishes. The part thrown out is called a polar body. The nuclear loops, however, in this case are not split, but simply one-half of their number are removed in their entirety. (*See first diagram.*) From that moment no further development takes place in the egg cell until fertilisation has occurred, and that process consists in the replacement of the lost half of the nucleus by another half nucleus, containing a similar series of rods or loops, from a sperm cell. All this, of course, is a matter of observation and fact, and not of theory.

Now we come to Weismannism proper :—Weismann supposes that these extremely minute rods, loops, or threads about

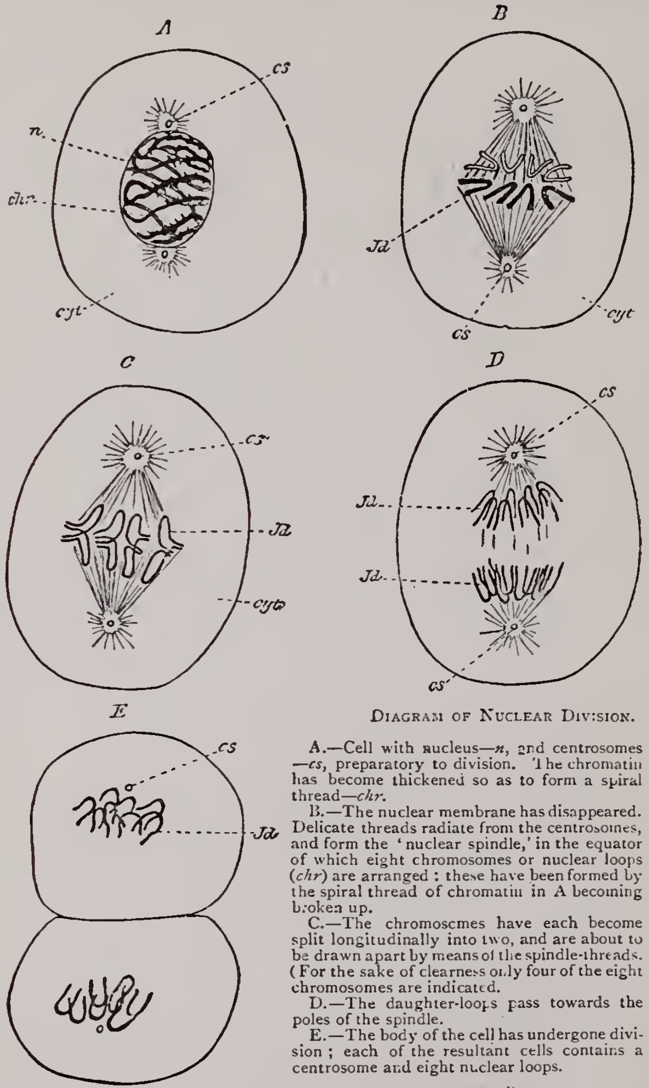

Diagram of Nuclear Division.

A.—Cell with nucleus—*n*, and centrosomes —*cs*, preparatory to division. The chromatin has become thickened so as to form a spiral thread—*chr.*

B.—The nuclear membrane has disappeared. Delicate threads radiate from the centrosomes, and form the 'nuclear spindle,' in the equator of which eight chromosomes or nuclear loops (*chr*) are arranged : these have been formed by the spiral thread of chromatin in A becoming broken up.

C.—The chromosomes have each become split longitudinally into two, and are about to be drawn apart by means of the spindle-threads. (For the sake of clearness only four of the eight chromosomes are indicated.

D.—The daughter-loops pass towards the poles of the spindle.

E.—The body of the cell has undergone division ; each of the resultant cells contains a centrosome and eight nuclear loops.

the distribution of which nature takes so much trouble, consist of masses of the hereditary substance, to which he gives the name of idioplasm or germ plasm. The process of throwing away half the nuclear rods in an egg cell and of division into two in a sperm cell, Weismann describes as *a reducing division*, which process he says holds good for ovum and sperm cells in all animals and, so far as is known, in plants also.

According to Weismann, all living matter is made up of vital units (the smallest capable of life), to which he gives the name of biophors, or life bearers. These biophors are neither atoms nor molecules, but consist of groups of molecules, between which chemical interaction is continually taking place. That is to say, life is not a chemical substance, but a complex chemical process, comparable to (though much more complicated than) the process of combustion which takes place in a candle flame. A flame is not stuff—not a mere substance—but a process of exchange between the wax or tallow on the one hand, and the air on the other.

Now, as all living matter consists of biophors, the differences in it can only depend on the differences in the biophors composing it. Biophors may differ in :

(*i.*) The number of their molecules.
(*ii.*) The composition of their individual molecules.
(*iii.*) The arrangement of the molecules within the biophor.

In order to illustrate difference which may depend upon difference of arrangement, apart from difference of composition, I may mention two well-known chemical substances, Ammonium cyanate and urea, the latter of which circulates as a waste product in the human body, and is got rid of by the kidneys. These substances both consist of Carbon, Nitrogen, Hydrogen, and Oxygen, in exactly similar proportions, and yet they are quite different substances both in appearance and properties. A still more familiar example may be given in the way in which three letters, say, may be differently combined. A, B, C, for instance, may be put together in five different ways. Still more, the twenty-six letters of the English Alphabet can be combined into the hundreds of thousands of different words in the English, German, French, Spanish, Italian, Latin, Dutch, and other languages, to say nothing of American, Lancashire, and Westmorland dialects, Cockney and thieves' slang, and others which have not yet been invented.

Taking, then, the comparatively few elements of which living matter is composed, the number of different biophors which can be built up from them is practically infinite.

It is not to be supposed, however, that the differences between fowl and fish or between a crested Fern and a plumose consist simply in the differences between their different individual biophors. The biophors are built up into higher and more complex units, and these again into still higher units, just as letters are built up into words, words into sentences, and sentences into books.

Weismann divides up the body of an animal or plant into an immense number of spots or areas, which he calls determinates. A determinate is the smallest part of the body which is independently variable. In a Fern, for instance, a determinant must be something smaller than a pinna, because one part of a pinna may vary while another remains normal. In Moly's pulcherrimum variety of P. angulare, for instance, the upper half of the pinna is frequently normal, while the lower half shows the pulcherrimum character. On an average, a determinate would perhaps correspond with a pinnule, though it may be smaller even than this. Each determinate has its character controlled or "determined" by a unit of idioplasm called a determinant, and which consists of a group of biophors. It is an independent vital unit, capable of multiplying, and having its constituent biophors built up in a particular order or arrangement. It has the same relation to a biophor that a molecule has to a chemical radical, or that a word has to a syllable.

The id is a still more complex vital unit, consisting of a group of many determinants, which are again built up in a definite and systematic order. Every id of the germ plasm is supposed to contain the whole of the elements which are necessary for the development of all subsequent idic stages (*i.e.*, stages of growth in an individual). If animals or plants existed (as not improbably they do) in the whole series of ancestors of which sexual reproduction had never occurred, their ids would be exactly similar to each other. Weismann expresses the opinion that those rod-like, loop-like or granular masses of chromatin in the nucleus—the chromosomes—are to be considered not as single ids but as series or agglomerations of ids. In some cases, as in Ascaris megalocephala (a kind of parasitic worm), the chromosomes can be seen to be made up of spherical bodies, like little beads strung together, and it is these beads which are supposed to be the ids.

But what have all these biophors and determinants and ids to do with heredity? I am coming to this now.

As I said before, it is a known fact that whenever a cell divides, the idioplasm of the nucleus divides with it and a portion passes into each daughter cell. It has also been long known that it is the nucleus of a cell which somehow governs its growth and character. If a one-celled organism be divided artificially in such a way that the whole of the nucleus is left in one part, the part which has no nucleus ceases to grow and soon dies, while the part containing the nucleus goes on growing and dividing as if nothing had happened.

Weismann supposes that the idioplasm of the nucleus governs the rest of the cell by the ids breaking up into their constituent biophors, which pass through the pores of the nuclear membrane into the cell body, and so work upon the crude sap which is absorbed into the cells as to convert it into protoplasm like themselves. He assumes that during development the idioplasm, being handed on from cell to cell (as we know it to be), is gradually disintegrated into smaller and smaller groups, until finally only one kind of determinant is contained in the cell, viz., that which has to determine it. At each stage of this breaking up, certain and particular determinants are given off and broken up into biophors, but only just sufficient are so given off to do the work required as development proceeds. That is to say, certain of the determinants remain in an inactive condition until the time comes for them to do their work. It is like a contractor, who, in building a house, keeps the bulk of his capital in the bank, only drawing out sufficient every week to pay for the work as it proceeds. If he paid all his money the first week to the men who laid the foundations, the men would of course go on the spree, and no more work would be done. This metaphor of the contractor is not quite exact, however. To make it so we should have to suppose that certain kinds of money only could buy excavating, and stonework, and carpenters' work, and plumbers' work, and plasterers' work, and painters' work, and so on, and we should have to suppose further that the contractor had his different kinds of money so arranged that they could only be got at in exactly the order in which they would be required.

But if the idioplasm is all used up in building the body, how is new idioplasm to be obtained when a new body has to be formed at the next generation, or when the old one has to be repaired in case of accident? The answer is that the idioplasm is not *all* used up, but a certain amount of it is preserved in an inactive or latent condition (as if it were money sealed up in a purse), and handed on from cell to cell until it reaches the place where the germ cells of the succeeding generation are to be found, when it is handed over to the new generation. This theory is called by Weismann the continuity of the germ plasm. The ids of which this latent germ plasm is composed are, moreover, capable of growing and multiplying without thereby becoming active or breaking up. Under certain abnormal circumstances certain of them are capable of becoming active, as it were, before their usual time, as when a cutting of a plant emits roots, although the ordinary root determinants had presumably passed into the roots of the plant when its first roots were formed.

We now come to another very important question, viz., What is the object of fertilisation, or, as Weismann calls it, Amphimixis?

Before sex was invented, as it were, we may suppose the various ids in the germ plasm of an individual to have been all exactly alike; but the individuals were not all alike: there were individual differences as there are now, and these personal differences between individuals corresponded to differences in the constitution of the ids of their germ plasms. When, however, two different individuals fused their germ plasms into one, the resulting germ plasm must have consisted of a mixture of ids of two different kinds. These two different kinds of ids, passing into the cells of the resulting daughter cells or daughter individuals, caused them to have a character intermediate between the characters of the two parents. When the second generation came to perform amphimixis with a generation formed from the fusion of two other individuals, the germ plasm of the third generation would presumably consist of ids of four different kinds, that of the fourth of eight, and so on until the ids of the germ plasm were all different from each other. But when amphimixis occurs, we might suppose that the number of ids in the germ plasm would be doubled and the germ cells consequently increased in bulk. This result is prevented, however, by the reducing divisions of which I have before spoken. It is obvious that if I wish to mix a glass of ginger-beer with a glass of stout, I shall require a glass double the size for the mixture. If, however, I throw away half the stout and half the ginger-beer before mixing them, an ordinary glass will suffice. What Nature does is to throw away half the ginger-beer (*i.e.*, the female germ plasm), but she provides an extra glass for the stout, and tries not to waste any of it—but she divides it all the same, and throws a good deal of it away eventually.

It is significant that in these reducing divisions, both male and female, the idants do not become split longitudinally, and their resulting halves become distributed equally amongst the two daughter nuclei, as in ordinary nuclear division—but one-half of the entire number of rods passes into one daughter nucleus and the other half into the other.

The result of all this is that every fresh amphimixis results in a different combination of ids, and that is why no two children of the same parents, whether animal or vegetable, are ever exactly alike. Or rather I should say that is the reason why the differences are often so great between individuals of the same family. There must be variation, independent of amphimixis, otherwise amphimixis itself could not cause variation. What, then, is the primary cause of variation? This is a question of extreme importance and interest to us as students of British Ferns.

It has been very largely assumed that differences of environment directly caused modifications of structure, and that these modifications were in some way directly transmitted to offspring. But Weismann says "No; modifications of structure caused by environment cannot be inherited, because the germ plasm is not derived from the body, but the body from the germ plasm." What, then, is the cause of variation in the germ plasm? Weismann says that the complicated constitution of the germ plasm is the cause of a condition in it of unstable equilibrium of nutrition, and, consequently, of slight irregularity of growth, and that this is the cause of continual minute variations in the structure of the germ plasm. These minute variations do not as a rule cause any *perceptible* change in the structure of the body, but when a number of them happen to become superposed one upon the other we get an accumulation, as it were, of slight modifications resulting in a perceptible variation. It is as though we had a sheet of water with very slight ripples upon the surface. So long as these ripples follow each other in regular succession they are scarcely noticeable, but if it should happen that three or four ripples coincide in point of time and place, then we should get a noticeable wave.

Having now given you a very rough and imperfect outline of Weismann's theory, I proceed to apply it to the solution of some of the problems connected with variation in our British Ferns. The problem of variation itself has been already dealt with, because no doubt the cause of variation in Ferns is the same as the cause of variation in other forms of vegetable and animal life.

If we come to examine Fern varieties in detail, we shall find that nearly all of them are cases either of excess or of deficiency of development in some part or parts of the plant. According to Weismann, these correspond to local inequalities in the nutrition of the germ plasm in the parent Fern. One thing you will all have noticed, viz., that you may sow spores of a perfectly normal Fern generation after generation without getting any appreciable variation in the seedlings. But if you once get a break—once get a variation, however small, from the normal type—and sow from that, you immediately get a number of fresh variations. Take Mr. Barnes's crested dilatatas and montanas, for example. Mr. Barnes first of all found a natural break differing comparatively little from the type—what we should call an ordinary variety. Sowing this, the result was a number of varieties much superior to (*i.e.*, more abnormal than) the parent; doubtless along with them were a large number inferior to the parent, and probably some quite normal ones. Mr. Barnes, however, like the wise man he was, threw the bad ones away and kept only the good ones. In this way almost any slight natural variation, by repeated sowings and selections, may be developed to almost any extent compatible with life. This is explained by the first variation affecting a few only of the ids of the germ plasm. Let us suppose for the sake of convenience that there were twenty ids in the germ plasm, and that, say, three of them were so modified as to produce cresting. Then, at the next generation we get a reducing division. It might happen that the crested ids, as I may call them, might be thrown out in the polar bodies, in which case we should get a return to the normal form. On the other hand, it might happen that ten normal ids of the egg cell might be thrown out, leaving seven normal and three crested. If this egg cell should happen to be fertilised by a sperm cell which had similarly thrown out all normal ids, we should get a new germ plasm, containing fourteen normal ids and six crested ones, in which the crested character would be intensified in the next generation. I may give you an ocular illustration of this by supposing the ids to be represented by coloured discs. I show you here the result of several different reducing divisions and recombinations of ids. (*Blackboard demonstration.*)

Let us now glance for a moment at the phenomenon of reversion or atavism. You all know that an organism will sometimes exhibit characters and peculiarities which cannot be detected in either of its parents, but which belonged to one or other of its grand-parents, or even to some ancestor many generations back. The explanation of this in Weismann's theory is very simple. I have already explained that the germ plasm of an individual contains ids, derived from a long line of ancestors. Every variety of recent origin probably contains some normal ids of the species to which it belongs. Our friend Mr. Druery can tell us that in raising young plants of A. f. f. Clarissima some of the offspring tend to run back to the normal form of A. filix-fœmina. The reason for this is that by a reducing division the germ cells have got rid of some of the Clarissima ids, and so the normal ids have obtained a majority and gained the upper hand. There are probably, however, some Clarissima ids still contained in the germ plasm of these degenerate forms, but these form only a small minority and are consequently unable to produce much impression upon the character of the plant. If, however, we raise again from these renegades we get a fresh series of reducing divisions, and in some of these it may happen that the Clarissima ids gain the upper hand, and so we again get a few Clarissima seedlings from the degenerated parents, although the bulk of the offspring are probably normal Athyrium filix-fœmina.

Let us take as another example Polypodium v. Cornubiense, which produces normal fronds among the dissected ones. In this Fern the abnormal ids have presumably only a very small working majority, and so the government is apt, as it were, to be caught napping and to be occasionally outvoted. Sometimes this defeat is so humiliating that the government resigns and the opposition takes office, that is to say, the Fern reverts entirely to the normal form. It is probable, however, that if we sowed spores from these reverted plants we should get fresh reducing divisions and recombinations, in some of which the advanced party would again gain the majority and again take on the reins of government. I am not aware that this has been done in this particular case, because Fern growers as a rule prefer to sow from their best plants and not from their worst. From the biological point of view, and for scientific reasons, however, it would be well worth while to occasionally sow from reverted forms and record the results.

If I have not yet quite exhausted your patience there is one other matter to which I should like to refer. There is a prevailing impression among Fern growers that if we sow spores from characteristic parts of a plant, we are more likely to get improved forms than if we sow from parts which bear the particular character in a less degree, or not at all. It is a common practice, for instance, to take the spores from crested tips of fronds and pinnæ, in the hope of getting improved crested forms in the offspring. I may say at once that this idea and practice does not fit in at all with Weismann's theory. According to Weismann, the germ plasm is the same in all parts of the plant, and we are therefore just as likely to get true seedlings of A. f. f. kalothrix by sowing from the worst fronds as by sowing from the best. This point can only be determined by a large number of impartial experiments, instituted for the express purpose of finding out the truth, and not for the purpose of either raising stock of good Ferns, or of confirming our preconceived notions. For my own part, I have never satisfied myself that there was anything to be gained by sowing from particular parts of a frond, and I am *certain* that it is quite possible to obtain characteristic seedlings of a variety by sowing from parts of the frond which do not bear the particular character in question.

There are many other questions connected with this subject into which I might enter—in fact, I might go on all day and all night too—but I fear I have already trespassed too much upon your patience. I have, however, given you the key and shown you how it is to be used. You can now proceed to work out problems for yourselves. If in another century it should be found that Weismann's theory will fit all the known facts, it will have a good chance of being accepted. If, on the other hand, it should be found that large masses of fact are inconsistent with it, then it must go where many other plausible theories have preceded it —into oblivion.

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